DOCUMENT RESUME

ED 120 515 CE 006 821

TITLE Construction Cluster Volume IV: [Concrete Work].
INSTITUTION Pennsylvania State Dept. of Justice, Harrisburg. Bureau of Correction.
PUB DATE 1 Jan 71
NOTE 172p.; For others in the series, see CE 006 818-822

EDRS PRICE MF-$0.83 HC-$8.69 Plus Postage
DESCRIPTORS Building Trades; *Cement Industry; *Construction Industry; *Curriculum Guides; *Instructional Materials; Integrated Curriculum; Job Skills; Occupational Clusters; Secondary Education; *Unit Plan

ABSTRACT

The document is the fourth of a series, to be integrated with a G.E.D. program, containing instructional materials for the construction cluster. The volume focuses on concrete work and consists of 20 instructional units which require a month of study. The units include: (1) uses of concrete and occupational information; (2) soils, drainage, and preparation of subgrade for concrete placement; (3) simple forms for sidewalks, footings, and patio slabs; (4) materials used in cement; (5) cement types and concrete mixes; (6) water for concrete; (7) air-entrained concrete; (8) concrete working tools; (9) estimating the quantity of concrete required for a given job; (10) mixing concrete; (11) testing concrete; (12) formwork and forming concrete; (13) reinforcing concrete; (14) joints, joining, and crack control; (15) handling and placing concrete; (16) concrete finishing; (17) concrete protection and curing techniques; (18) stripping forms from concrete; (19) special finishes, textures, and coloring; and (20) machine applications and modern techniques. Each unit includes the following information for the teacher: aim, instructional aids, equipment, primary references, introduction and motivation, a presentation of integrated concepts, application, evaluation criteria guideline, summary, suggested time and sequence listing, and supplemental references and resource materials. A bibliography is included. (EC)

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ED120515

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Commonwealth of Pennsylvania
Department of Justice
Bureau of Correction

# VOCATIONAL EDUCATION PROGRAM OF STUDIES

Elementary, Secondary Education Act
Title I

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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# CONSTRUCTION CLUSTER
# VOLUME IV

CE006821

January 1, 1971
Pennsylvania Bureau of Correction

Harry A. Snyder
Director of Education

# INTRODUCTION

The following information comprises one of seven volumes of instructional materials developed around a cluster of Construction Industries and Occupations. These instructional materials are primarily technical in focus but are written to be used in a cluster concept program as part of an integrated curriculum.

The materials are aimed at preparing students with basic skills necessary to enter a number of occupations in industries within the Construction cluster rather than providing an in-depth development of skill in any one occupation.

Each volume contains approximately one hundred twenty hours of instruction (about one month of study) and consists of twenty instructional units each having one or more specific lessons. Each unit is designed for six hours of instruction (three hours of technical laboratory experiences and three hours of related study in science, mathematics, communications and social studies) but may be varied at the instructor's discretion.

The seven volumes or cluster areas in the series are:

Volume I - Wood Structural Framing
II - Masonry Work
III - Plumbing
IV - Concrete Work
V - Electrical
VI - Air Conditioning and Refrigeration
VII - Heating and Ventilation

Students in the Construction cluster should be introduced to the technical and integrated content through several methods closely related to the industrial structure. Among these are line production and assembly, group projects, experimentation, unit studies and independent study. Team teaching techniques should be employed between the academic specialist and the technical specialist and coordinators.

It is recommended that an orientation program be offered students to familiarize them with the cluster areas available so they may select one they wish to pursue. The cluster instruction is designed to integrate with the regular G. E. D. program so students may receive an employable level of skill and a general academic background simultaneously.

As students select the technical cluster areas they wish to study, they should have the option to move through the G. E. D. content at their own speed using programed instructional materials, instructional television, computer assisted instruction and other individualized learning techniques. Technical and integrated concepts are introduced each day by the specialists involved.

After completion of one or more months of work within one cluster, a student could elect to study within another cluster providing, of course, this transfer is agreeable with the counselors, coordinators and instructors involved.

Lessons have been identified in the units. In most cases, however, there is only one lesson since each unit is limited to one

day or six hours of instruction. The units offer the instructor the essential materials, vis-a-vis the aims, instructional aids, topical outline and activities, suggested time sequence, evaluation guidelines, summary and references. The primary and supplemental references are directly related to the topics and are important to the instructors. A selected bibliography is attached at the end of each volume as recommended additional sources of information.

Pagination of the units in this volume has been identified by cluster (C), volume (I, II, etc.), unit (1, 2, etc.) and page (.1, .2, .3, etc.) within each unit.

# TABLE OF CONTENTS


| UNIT | | PAGE |
|---|---|---|
| 1 | Uses of Concrete and Occupational Information . . | C-IV-1.1 |
| 2 | Soils, Drainage, and Preparation of Subgrade for Concrete Placement. . . . . | C-IV-2.1 |
| 3 | Simple Forms for Sidewalks, Footings and Patio Slabs . . . . . | C-IV-3.1 |
| 4 | Materials Used in Cement--Types and Manufacture . | C-IV-4.1 |
| 5 | Cement Types and Concrete Mixes . . . . . | C-IV-5.1 |
| 6 | Water for Concrete. . . . . | C-IV-6.1 |
| 7 | Air-Entrained Concrete. . . . . | C-IV-7.1 |
| 8 | Concrete Working Tools. . . . . | C-IV-8.1 |
| 9 | Estimating the Quantity of Concrete Required for a Given Job . . . . . | C-IV-9.1 |
| 10 | Mixing Concrete . . . . . | C-IV-10.1 |
| 11 | Testing Concrete. . . . . | C-IV-11.1 |
| 12 | Formwork and Forming Concrete . . . . . | C-IV-12.1 |
| 13 | Reinforcing Concrete. . . . . | C-IV-13.1 |
| 14 | Joints, Joining and Crack Control . . . . . | C-IV-14.1 |
| 15 | Handling and Placing Concrete . . . . . | C-IV-15.1 |
| 16 | Concrete Finishing. . . . . | C-IV-16.1 |
| 17 | Concrete Protection and Curing Techniques . . . . | C-IV-17.1 |
| 18 | Stripping Forms from Concrete . . . . . | C-IV-18.1 |
| 19 | Special Finishes, Textures and Coloring . . . . . | C-IV-19.1 |
| 20 | Machine Applications and Modern Techniques. . . . | C-IV-20.1 |
| Bibliography. . . . . | | c-IV-i |

INSTRUCTOR'S UNIT PLAN

Unit 1
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Uses of Concrete and Occupational Information

AIM:

To acquaint students with the many contemporary uses of concrete and further, to acquaint students with occupational information--job requirements, responsibilities, pay scales and conditions of employment.

INSTRUCTIONAL AIDS:

Film - Harrisburg: Modern Talking Picture Service, Inc., J. P. Lilley & Sons, 2009 N. 3rd Street (16 mm, sound, color):
Shape of Safety (21 minutes)
Everything Under the Sun (20 minutes)
New Dimensions in Concrete (28-1/2 minutes)
Concrete in the Sixties--Report #7 and #8 (20 minutes each)

Film - Cement Makers--Americans at Work, Ann Arbor, Michigan: University of Michigan (14 minutes, 16 mm, sound, color).

Filmstrip - Cement Finisher, Milwaukee: Ray McCrory, Director of Life Advisement, West Division High School.

Slides - Teacher-made slides of uses of concrete and working conditions.

Worksheets - Teacher-developed worksheets to help students list and identify various aspects of vocational preference.

EQUIPMENT:

16 mm projector, 35 mm filmstrip projector, 35 mm slide projector, screen.

PRIMARY REFERENCES:

1) Akroyd, T. N. W., Concrete--Its Properties and Manufacture, Elmsford, N. Y.: Pergamon Press, Inc., 1962.

2) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

3) Concrete Technology--Student Manual, Albany, N. Y.: Delmar Publishers, Inc., 1965.

4) Proportioning Concrete Mixtures, Bulletin ST-100, Detroit: American Concrete Institute, 1962.

I. INTRODUCTION AND MOTIVATION

A. Have film, Everything Under the Sun, ready to run when students enter class.

B. Follow with discussion of other things made from concrete and show other selected films.

C. Have as many pictures of uses of concrete as possible on display.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Uses of concrete. | 1. To present an overview of uses of concrete to increase the likeliness of students being receptive to occupational information.<br>a. Paving<br>b. Structural uses<br>1) Buildings<br>2) Bridges<br>3) Piers<br>4) Etc.<br>c. Farming with concrete<br>d. Concrete and water resources<br><br>2. Technical aspects--general.<br>a. Reinforced concrete<br>b. Prestressed concrete<br>c. Tilt-up construction<br>d. Concrete shell roofs<br>e. Oil well cementing | 1. Develop concept of work done by technicians and engineers in cement and concrete research.<br>a. Research and development<br>b. Structure design<br>c. Testing<br>d. Quality control |
| B. Employment outlook. | 1. Although there have been cutbacks in the construction industry, it appears a steady growth will be the pattern in the future.<br>a. Construction value growth could exceed 91 billion by 1976.<br>b. Continued needs of more people and technological growth<br>c. Ecology programs<br><br>2. There is and will be a continued need for trained personnel in the construction trades. | |
| C. Types of jobs available. | 1. General concrete worker.<br>a. Employed by small contractors must have broad knowledge and skills<br>b. Employed by large contractors may not have to set forms but must have broad knowledge and skills<br><br>2. Specialists.<br>a. Laboratory technicians<br>b. Placement specialists<br>1) Must be able to place concrete in high places<br>2) Must be able to place materials in unusual situations<br>a) Tunnels<br>b) Dams<br>c. Finishing specialists must be knowledgeable about and skilled in all types of finishing techniques | 1. Levels of understanding of science for various levels of employment. |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| 1. Discuss volume of materials used, total product value, and wages paid.<br>a. Use this information to introduce<br>1) Large numbers--thousands, millions, etc.<br>2) General concept of volume--tonnage, cubic yards, etc. | 1. Writing letters.<br>a. Have students write letters requesting information relative to total product value, tonnage used, etc. | 1. The economic impact of concrete on contemporary American society. |
| 1. Building a general understanding of sampling methods used to get statistical data and counting methods used by census to provide information on employment needs. | 1. Researching information on current numbers employed from sources such as:<br>a. Occupational handbook<br>b. Statistical abstracts<br>c. Etc. | 1. The U. S. Census Bureau and its function. |
| 1. Discussion of general knowledge of math skills needed for various levels of employment. | 1. Communication skills needed for various levels of employment.<br>2. Writing of job specifications and definitions (e.g., U. S. Government Contracts). | 1. Discussion of growth of education requirements as technology has advanced. |

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| D. Characteristics of persons employed by concrete industry. | 1. Many people from all walks of life are employed, each with different characteristics. However, the general concrete worker tends to have these characteristics.<br>a. Reasonable physical strength<br>b. Reasonable stamina<br>c. Likes to work--physically<br>d. Likes to work outdoors<br>e. Does not worry about some dirt or dust in his job<br>f. Has a high level of responsibility<br>1) Once concrete is placed, it must be watched and worked<br>2) Workers cannot leave concrete in need of finishing for most personal reasons | |
| E. Pay scales. | 1. Discuss pay scales for various areas of the United States and also for various levels of employment.<br><br>2. Union involvement. | |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| | 1. Research job definitions for employees in concrete work.<br>a. Written presentations<br>b. Oral presentations<br><br>2. Interview concrete or cement workers from various levels of employment.<br><br>3. Job listings in newspapers and journals. | 1. Writing employment contracts. |
| 1. Development of an understanding of how to compute wages earned.<br>a. Simple addition<br>b. Simple subtraction<br>c. Simple multiplication | | 1. Develop role of union in regard to pay scales and employment conditions and practices.<br><br>2. Discuss wages paid to construction workers and slow-up in construction starts. |

III. APPLICATION

A. Show film: Cement Makers--Americans at Work and filmstrip: Cement Finisher.

B. Discuss the various occupations in the concrete working trades and, if possible, have guest speakers.

C. Complete worksheets for occupational guidance purposes.

IV. EVALUATION CRITERIA GUIDELINE

A. Have students list major uses of concrete.

B. Have students list various types of concrete material uses, e.g. reinforced, prestressed, air entrained, etc.

C. Have students list job qualifications of an occupation of their choice.

D. Discuss employment potentials.

V. SUMMARY

A. The concrete working portion of the construction industry is a large and important one. Many structures, highways, bridges, and aircraft runways are constructed from the concrete material. There are many job classifications related to concrete working and the employment potential is very good. Concrete workers work hard but are well paid.

VI. SUGGESTED TIME AND SEQUENCE LISTING

45 minutes -- Introduction and motivation. Show film: Everything Under the Sun

30 minutes -- Uses of concrete

60 minutes -- Occupational information

60 minutes -- Math concepts

60 minutes -- Communications concepts--job classifications--speaker from industry

45 minutes -- Social studies concepts

60 minutes -- Summary and evaluation

## VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Dictionary of Occupational Titles--Volume I--Definitions of Titles, Washington, D. C.: U. S. Government Printing Office, Third Edition.

2) Occupational Outlook Handbook, Washington, D. C.: Government Printing Office, 1970.

INSTRUCTOR'S UNIT PLAN

Unit 2
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Soils, Drainage, and Preparation of Subgrade for Concrete Placement

AIM:

To teach the importance and methods of base preparation which proceeds the proper and successful placement of concrete.

INSTRUCTIONAL AIDS:

Film - Construction of a Concrete Industrial Floor on the Ground, Chicago: Portland Cement Association, Photographic Services Section, 33 W. Grand Ave. (32-1/2 minutes, 16 mm, sound, color).

Film - Foundations and Concrete, New York: Du Art Film Labs, Inc., 245 West 55th Street (26 minutes, 16 mm, sound, color).

Transparencies - Teacher-made transparencies showing cross sections of various subgrade materials and their placement.

Samples - Samples of various sizes and grades of stones used for base materials.

EQUIPMENT:

16 mm projector, overhead projector, screen.

Transit, leveling rod, stakes, hammers, saws, level, string, shovels and base materials.

PRIMARY REFERENCES:

1) Akroyd, T. N. W., Concrete--Its Properties and Manufacture, Elmsford, N. Y.: Pergamon Press, Inc., 1962.

2) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

3) Krebs, Robert and Walker, R., Highway Materials, New York: McGraw-Hill Book Company, 1970.

I. INTRODUCTION AND MOTIVATION

A. If possible, have students view cracked or broken foundations, sidewalks or other concrete structures and ask for opinions as to the cause of the cracks.

B. Show film: Construction of a Concrete Industrial Floor on the Ground.

C. Proceed into body of the lesson.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Soil factors involved in subgrade preparation. | 1. Load bearing characteristics of different soils.<br>2. Drainage characteristics of different soils.<br>3. Soil behavior under conditions of freezing and thawing.<br>4. Different types of soils.<br>5. Soil behavior under wet and dry conditions.<br>6. Need for stable, physical support under concrete. | 1. Testing of soils for:<br>a. Organic content<br>b. Water retention<br>c. Particle sizes<br>d. Aggregate ratios<br>e. Compaction<br>f. Volume change due to freezing and thawing<br>2. On-site testing procedures (borings, etc.). |
| B. Drainage requirements for subgrade preparation. | 1. Effects of excess moisture on stability of soil.<br>2. Comparative expansion during freezing of wet and dry soils.<br>3. Prevention of hydraulic pressure.<br>4. Contamination of wet concrete.<br>5. Types of soil pipe and tile.<br>6. Placing of soil pipe or drain tile.<br>7. Bedding material used to fill around tile. | 1. Research on amount of fall needed to prevent settling in the tile.<br>2. Natural flow patterns of ground water.<br>3. Research on molecular attraction of ground water to soil particles. |
| C. Grading for elevations and for site drainage. | 1. Use of level and transit.<br>2. Staking out excavation. | |
| D. Base materials and their application. | 1. Condition of excavated surface.<br>a. Undisturbed soil--virgin soil<br>b. Disturbed soil.<br>c. Removal of topsoil and all organic material<br>d. Trimming and smoothing subsoil surface<br>2. Materials used.<br>a. Sand<br>b. Crushed stone or gravel<br>c. Pea stone<br>d. Vapor barriers and insulation<br>1) Polyethylene<br>2) Styrofoam | |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| 1. Comparisons of aggregate surface area of different soil types.<br><br>2. Calculations on load bearing qualities.<br><br>3. Calculate volumes and densities for different compaction percentages. | 1. USA standards for subgrade preparation.<br><br>2. State and local building codes.<br><br>3. Writing of architectural specifications.<br><br>4. Exchange of information between owner, architect, contractor, testing service. | 1. Different soil types in different geographic areas.<br><br>2. Soil maps from U. S. Dept. of Agriculture.<br><br>3. Extra costs involved in using concrete in some communities because of soil conditions--effect on local economy and industrial development. |
| 1. Calculating amount of fall for drainage.<br><br>2. Cost calculations on pipe or tile:<br>a. Material<br>b. Labor<br>c. Equipment<br><br>3. Calculations on amount and size of pipe or tile needed.<br><br>4. Calculations of hydraulic pressures created by lack of drainage.<br><br>5. Calculations for volume of surface water runoff. | 1. State and local building codes.<br><br>2. Public notice and hearings on drain installations.<br><br>3. Architectural specifications.<br><br>4. Engineering drawings. | 1. Effects of excess water on working conditions.<br><br>2. Division of labor for trenching and laying of tile.<br><br>3. Water rights factors of increased flow--diverted runoff, etc.<br><br>4. Ecological effects of reducing ground water on the building site.<br><br>5. County drain system and disposal of water.<br><br>6. Desirability of "dry" structures. |
| 1. Field work in mathematics.<br>a. Use of transit<br>b. Computation of earth to be moved<br>c. Geometry applied in layout of stakes, etc. | 1. Reading of site blueprints. | |
| 1. Calculate amount of base material required.<br><br>2. Calculate cost of base material.<br><br>3. Calculate time and labor requirements for preparation of base. | 1. Ordering of base materials from supplier.<br><br>2. Written or verbal instructions for delivery address, time of delivery, placement of load.<br><br>3. Special instructions regarding wires, pipes, drains, openings, etc. | 1. Local business, contractors, suppliers, etc. involved.<br><br>2. Methods of payment for materials and services. |

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

| INSTRUCTIONAL TOPICS | TECHNICAL CONCEPTS | SCIENCE |
|---|---|---|
| | 3. Application.<br>a. Low or uneven areas filled with sand and tamped<br>b. Top 4-6 inches of subgrade should be sand, gravel or crushed stone<br>c. Subgrade surface to be uniform and evenly compacted<br>d. Vapor barriers applied as per specifications | |

TO BE DEVELOPED

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
| --- | --- | --- |
| | | |

## III. APPLICATION

A. Present reasons for preparation of the subgrade and the need for careful preparation done with honesty in terms of virgin soil aspects. Present subgrade materials and their on-site application.

B. Practical application:
1. Lay out and prepare site for sidewalk, building footing or other small job.
2. Locate grade stakes.
3. Excavate to required depth, trim and apply subgrade aggregate.
4. Tamp subgrade aggregate and prepare a uniform surface.

## IV. EVALUATION CRITERIA GUIDELINE

A. Explain reasons why subgrade preparation is important.

B. What depth should subgrade aggregate be? Why?

C. How is proper drainage obtained under concrete?

D. List three materials used as subgrade aggregate.

## V. SUMMARY

A. Site preparation and the obtaining of a sound subgrade is an important aspect of concrete working. Concrete placement must be made on a solid, stable well-drained base. The soil base should be virgin and free of organic material.

## VI. SUGGESTED TIME AND SEQUENCE LISTING

60 minutes -- Introduction and showing film: Construction of a Concrete Industrial Floor on the Ground

60 minutes -- Presentation of lesson content

90 minutes -- Integrated curriculum concepts

120 minutes -- Practical application

30 minutes -- Summary and evaluation

## VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Recommended Practices for Concrete Floor and Slab Construction, Bulletin ACI-302-69, Detroit: American Concrete Institute, 1969.

2) Scott, Ronald F. and Schoustra, J. J., Soil Mechanics and Engineering, New York: McGraw-Hill Book Company, 1968.

INSTRUCTOR'S UNIT PLAN

Unit 3
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Simple Forms for Sidewalks, Footings and Patio Slabs

AIM:

To teach the construction practices related to simple concrete forms.

INSTRUCTIONAL AIDS:

Film - How to Build New Shapes in Concrete, Harrisburg: Modern Talking Picture Service, Inc., J. P. Lilley & Sons, 2009 N. 3rd Street (18 minutes, 16 mm, sound, color).

Transparencies - Teacher-made transparencies showing various form types and the placement of structural members for on-site constructed forms.

Samples - Samples of common lumber sizes, rails, bolts, and ties frequently used in on-site form construction.

EQUIPMENT:

16 mm projector, overhead projector, screen.

Transit, leveling rod, stakes, 2 x 4, 2 x 6, 2 x 8, and other sizes of lumber as required, hammers, saws, level, string, shovels, and sledge hammer.

PRIMARY REFERENCES:

1) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

2) Formwork for Concrete, Detroit: American Concrete Institute, 1969.

3) Huff, Darrell, How to Work with Concrete and Masonry, New York: Harper & Row Publishers, Inc., 1970.

4) McMillan, A. B., Forms and Centering, Part I, Scranton, Pa.: International Correspondence Schools, 1956.

I. INTRODUCTION AND MOTIVATION

A. Introduce and show film: How to Build New Shapes in Concrete. Use the film as a starting point to lead into discussion relative to form building.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Principles of good form construction. | 1. A well-designed form should:<br>a. Be easily erected<br>b. Be easily stripped<br>c. Be readily leveled or plumbed<br>d. Be rigid enough to prevent distortion by concrete pressures<br>e. Enable reuse of material<br>f. Provide some means of cleaning debris from formed area | |
| B. Pressure from freshly poured concrete. | 1. Pressures developed are the product of the weight of a cubic foot of concrete times the area times the depth.<br>a. Weight per cubic foot 140 pounds<br>b. Initial set time<br><br>2. Control of pressure height, width, length relationships.<br>a. Force triangles | 1. Pressure forces of a true liquid.<br>a. Relating the forces to concrete which acts as a true liquid<br>b. Basic hydraulic or hydrostatic principles |
| | | |
| C. Materials for forms. | 1. Types of material used.<br>a. Solid wood<br>1) Douglas fir<br>2) Spruce<br>3) Yellow pine<br>b. Manufactured wood<br>1) Exterior plywood<br>2) Concrete form plywood<br>c. Steel<br>1) Sheet metal, usually 10 ga or heavier<br>2) Angles, channels and other structural shapes<br>3) Most steel forms are commercially prepared<br><br>2. Fasteners.<br>a. Common wire nails<br>b. Duplex or double headed nails<br>1) Commonly called scaffold or erection nails<br>c. Sizes<br>1) Common nails--8 to 20 penny lengths<br>2) Double headed nails--10 and 16 penny lengths<br>d. Bolts--common bolts--5/16" to 3/8" diameter with lengths as required<br>e. Patented ties of various types<br>f. Wire--when carefully used | 1. Strength characteristics of various types of wood used for forms.<br><br>2. Grain and splitting characteristics of form woods.<br><br>3. Water resistant adhesives.<br><br>4. Experiments with nails to identify their holding power. |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| 1. Computation of:<br>a. Area<br>b. Volume<br>c. Weights | 1. Reading specifications for footings, sidewalks, patios.<br>a. Reading for understanding and accurate interpretation | 1. Study of U. S. highway system with consideration of:<br>a. Safety<br>b. Communications<br>c. Economy |
| 1. Computation of area of irregular shapes.<br><br>2. Computation of volume and weights of irregular shapes. | | 1. Safety regulations in the building trades.<br>a. Building excavation safety<br>b. Scaffold safety<br>c. Cassion safety<br>d. Forming safety<br><br>2. Structural safety and margin of safety or safety factors in commercial buildings.<br>a. Collapse of some public buildings<br>b. Liability laws |
| 1. Estimating materials required for formwork.<br><br>2. Cost breakdown.<br>a. Excavation<br>b. Material<br>c. Labor--erection<br>d. Labor--stripping<br><br>3. Translation of penny size to inches. | 1. Reading catalogs about commercial forms--read for understanding.<br><br>2. Writing requisitions for commercial forms.<br><br>3. Reading and understanding strength of material literature.<br>a. Materials<br>b. Concrete<br>c. Holding power of nails | 1. Review of some outstanding concrete structures. |

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| D. Footing form construction. | 1. Trench footings--use of soil as form where it will retain its shape and withstand pressure of concrete.<br><br>2. Simple one-piece sheathing forms.<br>a. Stake size and placement<br>b. Sheathing sizes<br>1) Usually 1" x 8" or 2" x 8"<br>c. Stake and sheathing bracing<br>1) Diagonal bracing<br>2) Spreader bracing | |
| E. Sidewalk and patio forms. | 1. Same principles as one-piece sheathing forms used for footers.<br><br>2. Necessity of good straight well-braced edge forms.<br><br>3. Forming curves or radii.<br>a. Materials used<br>b. Tangent points and fairing of curve into straight runs<br>c. Proper bracing techniques | |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| 1. Geometry as it applies to various triangles formed by brace members.<br>a. Strength of diagonal braces<br><br>2. Geometry as it relates to laying out various shapes.<br>a. Rectangle<br>b. Square<br>c. Circles<br>d. Arcs<br>e. Checking for accuracy | 1. Building vocabulary as it relates to forms.<br>a. Stakes<br>b. Spreader<br>c. Ranger-sheathing<br>d. Whaler<br>e. Ties<br>f. Etc. | |
| 1. Principles of tangents of circles.<br><br>2. Computation of correct center point for scribing curves for walks, etc. | | 1. Building codes as they relate to sidewalks, gutters and drainage.<br><br>2. Enforcement practices for sidewalk repair and snow removal. |

III. APPLICATION

A. Discuss need for formwork in concrete and point up the requirements of shape, strength, levelness, etc.

B. Demonstrate uses of various sizes of lumber and why each was selected.

C. In a practical application session, demonstrate how to use the transit, assemble forms, drive stakes and other aspects of form construction. Use subgrade prepared in Lesson No. 2 for practical forming experience.

IV. EVALUATION CRITERIA GUIDELINE

A. What is a trench form? Where is it used?

B. What pressures are exerted against a form?

C. Why shouldn't stakes be driven inside a concrete form?

D. Why must concrete forms be oiled?

E. Why is accuracy in building a concrete form essential?

F. Why is it important that a concrete form be strong and adequately braced?

V. SUMMARY

A. Concrete, being a plastic material when first mixed, must be contained in some type of form for most jobs. Since concrete is quite heavy, the forms must be strong enough to resist the great pressures exerted upon them by the concrete. Also, since the form delineates the shape of the finished concrete, a shape which cannot be easily changed, it is necessary that the forms be accurately constructed.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Introduction and motivation

90 minutes -- Integrated curriculum concepts

60 minutes -- Instruction on forming principles

150 minutes -- Practical application

30 minutes -- Summary and evaluation

## VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Concrete Form Construction, Albany, New York: Delmar Publishers, Inc., 1965.

2) U. S. A. Standard Recommended Practices for Concrete Formwork, Detroit: American Concrete Institute, 1968.

3) Wagner, Willis H., Modern Carpentry, Homewood, Ill.: Goodheart-Willcox Company, Inc., 1967.

INSTRUCTOR'S UNIT PLAN

| | |
|---|---|
| Unit | 4 |
| Lesson | 1 |
| Time | 6 Hours |

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Materials Used in Cement--Types and Manufacture

AIM:

To familiarize students with what constitutes a cement and acquaint him with the types and manufacture.

INSTRUCTIONAL AIDS:

Film - From Mountains to Microns, Harrisburg: Modern Talking Picture Service, Inc., J. P. Lilley & Sons, 2009 N. 3rd Street (24-1/2 minutes, 16 mm, sound, color).

Film - Story of Portland Cement, Minneapolis: Bemis Bros. Bag Company, Packaging Service (36 minutes, 16 mm, sound, color).

Samples - Raw materials used in cement manufacture: limestone, cement rock, oyster shells, coquina shells, clay shale, silica sand, iron ore. Various types of cement: portland, air entraining portland, white cement.

EQUIPMENT:

16 mm projector, screen, microscope.

PRIMARY REFERENCES:

1) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

2) Concrete Technology--Student Manual, Albany, N. Y.: Delmar Publishers, Inc., 1965.

3) Manual of Concrete Practice, Part I, Detroit: American Concrete Institute, Publications Department, Box 4754, 1968.

4) McMillan, F. R., Concrete Primer, Detroit: American Concrete Institute, 1958.

I. INTRODUCTION AND MOTIVATION

A. Show and discuss some of the raw materials used in cement. Examine materials, under a microscope, in both the raw and ground state. During discussion, mix some portland cement and from time to time make note of the change in consistency.

B. Show film: From Mountains to Microns or Story of Portland Cement.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Portland cement. | 1. Definition--A closely controlled chemical compound of calcium, silica, alumina, iron oxide, and small amounts of other materials to which gypsum is added, after calcining, to regulate setting time.<br><br>2. Portland cement is a type of cement and not a brand name.<br><br>3. Properties of cement body:<br>a. Finely ground compound<br>b. In purchased state is a dry compound<br>c. Must become plastic when mixed with water<br>d. Must set and harden by the chemical reaction called hydration | 1. Present principles and properties of materials.<br><br>2. Develop an understanding of compounds, solutions, etc.<br><br>3. Develop an understanding of hydration.<br><br>4. Chemical composition of cements. |
| B. Raw materials. | 1. Silica materials (siliceous).<br>a. Silica clay<br>b. Silica sand<br><br>2. Lime materials (calcareous).<br>a. Limestone<br>b. Cement rock<br>c. Oyster shells<br>d. Coquina shells<br>e. Marl shells<br>f. Marl<br><br>3. Iron materials (ferriferous).<br>a. Iron shale<br>b. Iron ore<br><br>4. Alumina materials (argillaceous)<br>a. Alumina<br>b. Bauxite | 1. Explain and experiment with:<br>a. Silica<br>b. Lime (calcium)<br>c. Iron oxides<br>d. Alumina<br><br>2. Learn appropriate symbols. |
| C. Manufacture. | 1. Quarrying--extraction of the raw materials from the earth.<br>a. Blast quarrying<br>b. Combination of blast and drag line or open pit<br><br>2. Grinding<br>a. Raw grinding--breaking materials to approximately 4" in size or smaller<br>b. Hammer mills--to reduce materials to approximately 3/4" in size<br>c. Pulverizing--reducing materials to powder<br><br>3. Blending--initial mixing of materials to correct proportions.<br>a. Various proportions for different cements | 1. Principles of reduction by physical means:<br>a. Crushing<br>b. Grinding<br><br>2. Principles of material separation:<br>a. Screening<br>b. Air flotation<br>c. Etc.<br><br>3. How different types of raw material mixtures result in different types of cement.<br><br>4. Experiments with calcination and fusion of materials. |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| 1. Equations for hydration.<br><br>2. Computation of quantities.<br>a. Proportion for compounds<br>b. Quantities required for a desired volume of cement | 1. Development of vocabulary related to cement materials and cement compounds. | 1. History of the cement industry--uses of cement by:<br>a. Assyrians<br>b. Egyptians--pryamids<br>c. Romans--Colosseum<br><br>2. Importance and economic impact of cement industry--past and present. |
| | 1. Research and writing of a paper concerning quantities of materials used or the importance of the cement industry. | 1. Industries involved in support functions of the cement industry such as:<br>a. Manufacturing of equipment<br>b. Machine repair<br>c. Shipping<br><br>2. Development of processes using new materials. |
| 1. Computation of mesh or grain size--the concepts of size from very large to microns.<br><br>2. Proportions as they relate to blending materials for various cements. | 1. Writing specifications for cements--refer to ASTM standard specifications.<br><br>2. Reading product information and accurately interpreting the information. | 1. John Smeaton's discovery concerning burned limestone and its effect on present underwater structures.<br><br>2. Joseph Aspdin and the patent for portland cement.<br><br>3. Jobs created by the cement industry.<br><br>4. Building standards or code changes as a result of cement product improvements. |

II. PRESENTATION OF INTEGRATED CONCEPTS

RELATED CONCEPTS

| INSTRUCTIONAL TOPICS | TECHNICAL CONCEPTS | SCIENCE |
|---|---|---|
| | 4. Powdering or fine grinding.<br>a. Wet or dry processes<br>b. Ball or tube mills<br>c. Ground to .025" or to pass through 40,000 mesh screen<br><br>5. Burning--calcining to incipient fusion the blended materials in a kiln at temperatures from 2600° to 3000°F.<br>a. Clinker formation<br>b. Cooling and pulverizing<br>c. Adding gypsum<br><br>6. Regrinding or fine grinding. | 5. Chemical reaction as a result of burning. |
| D. Packaging. | 1. Bulk shipment by rail or truck.<br><br>2. Barrel shipment--376 lbs. per barrel.<br><br>3. Bag shipment--94 lbs. per bag. | 1. Package design to prevent premature hydration from ground moisture and atmospheric moisture. |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| | | |
| 1. Computation of bulk quantities--volume--weight situations. | 1. Reading information on packages.<br>a. Manufacturer<br>b. Content description<br>c. Weight<br>d. Etc. | 1. Uniform packing laws and product labeling regulations.<br><br>2. Consumer knowledge aspects. |

III. APPLICATION

A. Have students examine materials under a microscope. Crush and grind raw materials and again examine under the microscope.

B. Have students become familiar with the cement analysis on the bag. Emphasize the importance of knowing the materials and their properties.

C. Have students use their ground materials and develop a cement.

D. Have students modify a prepared cement by adding various ingredients, i.e., gypsum, silica, stearates, etc. Test results.

IV. EVALUATION CRITERIA GUIDELINE

A. Ascertain that students can differentiate between cement and concrete. Check terminology.

B. Have students list the basic materials in portland cement.

C. Have students list the basic steps in the manufacture of portland cement.

D. Have students identify the most commonly used type of cement. List the five main types of cement and their uses.

V. SUMMARY

A. Cement is a compound of lime, silica, iron oxide, alumina and gypsum which, when mixed with water, sets and hardens by the chemical reaction of hydration. Cement is manufactured by carefully blending the correct proportions of ingredients, burning them to a point of incipient fusion, regrinding them, and adding gypsum to control setting time. Special cement compounds serve special purposes and the concrete worker must know the cement types and their uses.

VI. SUGGESTED TIME AND SEQUENCE LISTING

45 minutes -- Introduce and show film: From Mountains to Microns or Story of Portland Cement

60 minutes -- Lecture, demonstration, discussion about materials

95 minutes -- Experimentation

140 minutes -- Integrated curriculum concepts

20 minutes -- Summary and evaluation

## VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Admixtures for Concrete, Bulletin 60-64, Detroit: American Concrete Institute, Committee 212, 1963.

2) Guide for Structural Lightweight Aggregate Concrete, Bulletin 64-39, Detroit: American Concrete Institute, Committee 213, 1967.

3) Selection and Use of Aggregates for Concrete, Bulletin 58-24, Detroit: American Concrete Institute, Committee 621, 1961.

INSTRUCTOR'S UNIT PLAN

Unit 5
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Cement Types and Concrete Mixes

AIM:

To teach the versatility available when concrete mixes are designed for different purposes. To develop an understanding of basic concrete proportions and mixes.

INSTRUCTIONAL AIDS:

Film - Principles of Quality Concrete, Harrisburg: Modern Talking Picture Service, Inc., J. P. Lilley & Sons, 2009 N. 3rd Street (23 minutes, 16 mm, sound, color).

Film - How to Make Quality Concrete, East Lansing, Michigan: Michigan State University (30 minutes, 16 mm, sound, color).

Film - Quality Ready Mixed Concrete, Harrisburg: Modern Talking Picture Service, Inc., J. P. Lilley & Sons, 2009 N. 3rd Street (31 minutes, 16 mm, sound, color).

Transparencies - Teacher-made transparencies showing mixes, proportions and procedures.

Samples - Pre-prepared samples for test purposes or samples which had been subject to test with test results.

EQUIPMENT:

16 mm projector, overhead projector, screen.

Samples and compression test machine.

PRIMARY REFERENCES:

1) Akroyd, T. N. W., Concrete--Its Properties and Manufacture, Elmsford, N. Y.: Pergamon Press, Inc., 1962.

2) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

3) Design and Control of Concrete Mixtures, Chicago: Portland Cement Association, 1963, Tenth Edition.

4) Proportioning Concrete Mixtures, Bulletin ST-100, Detroit: American Concrete Institute, 1962.

## I. INTRODUCTION AND MOTIVATION

A. Have pre-prepared samples set up for subjection to shear or compression tests. Run several tests and elicit responses from students concerning why certain samples break more readily than others. Build on student responses and lead into the lesson. Direct discussion toward necessity of understanding the cement material and then progress to proportions of concrete mixes.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Types of Portland Cement. | 1. Portland Cement is classified by type to identify special qualities.<br>a. Type I--general purpose cement for normal or general use where no special properties are required<br>b. Type II--modified portland cement<br>1) Moderate heat of hydration<br>2) Resistance to sulfate attack<br>3) Used for massive construction<br>c. Type III--high early strength<br>1) Sets up quickly<br>2) Attains high strength in one to three days<br>d. Type IV--low heat of hydration<br>1) Used where massive quantity requires low heat of hydration<br>e. Type V--sulfate resisting<br>1) Used where high level of alkalinity is present<br>f. Air entraining<br>1) Available in types IA, IIA, IIIA<br>2) Contains air-entraining agent to generate air bubbles during mixing<br>3) Used in high frost and freeze-thaw situations<br>g. White portland cement<br>1) Used where white color is desired<br>h. Pozzolan portland cement<br>1) High silica cement<br>2) Used in underwater structures<br>i. Special cements | 1. The effect of the composition of cement as it relates to use.<br><br>2. Heat of chemical reaction during hydration.<br><br>3. Air-producing agents for cement compounds.<br><br>4. Effectiveness of silicas and other waterproofing agents. |
| B. Properties of quality concrete | 1. Properties during workable state.<br>a. Proper mix proportion<br>b. Consistency--degree of wetness or dryness<br>c. Uniformity--the concrete body must be uniformly mixed and hence, uniform throughout<br>d. Workability--the mix must be workable without excessive effort | 1. Experiment with various cement aggregate proportions to find most economical proportions.<br><br>2. Find moisture content of wet sand and stone aggregate.<br><br>3. Freeze a sample of concrete and study the effects.<br>a. Single freeze for long period of time<br>b. Repeated freeze-thaw situations |

## TO BE DEVELOPED

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| 1. Proportion as it relates to materials in cement types.<br><br>2. Computations of air in air-entrained concrete. | 1. Have students develop vocabularly and word lists relative to cement types. | 1. The impact of technology on society.<br>a. Structures of concrete made possible by research and advances in cement types<br>b. Effect on the economy by being able to work concrete in cold weather<br><br>2. Federal aid programs in terms of redevelopment and highway construction.<br>a. Effect of increased transportation facilities on society |
| 1. Computations related to moisture in aggregates.<br>a. Fine aggregate--sand<br>b. Coarse aggregate--stone<br><br>2. Study simple formulas requiring solving for one unknown.<br>a. Cement factor = $\frac{27 \text{ cu.ft.}}{\text{yield}}$ = bag/cu.yd. | 1. Inquire of local concrete companies the source of their supply of materials--study material reports.<br><br>2. Read charts and tables dealing with mixing water quantities, slump ranges, compressive strength, etc.<br>a. Read for understanding<br><br>3. Fill in quantity required tables and test report data.<br>a. Write interpretive reports on test data | |

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| | 2. Properties in the use state or when hardened.<br>a. Strength--concrete design must produce adequate strength for a sound structure<br>b. Durability--must be durable in terms of use and weather it will be subjected to<br>c. Abrasion resistance--must wear well<br>d. Watertightness--concrete must resist water penetration<br><br>3. Properties of economy.<br>a. Must be designed to use proper ratios of water, cement, and aggregates to produce desired strength at lowest cost<br>b. Must be economical to place and work | 4. Subject a concrete sample to:<br>a. Heat<br>b. Acids<br>c. Strong alkalines |
| C. Conditions affecting concrete mixes.<br><br>1. Exposure. | 1. Each exposure condition requires certain water-cement ratios. These have been established to include a maximum water and minimum cement content.<br>a. Normal exposure<br>1) Cement--6 bags/cu.yd.<br>2) Water--6 gallons/bag<br>b. Mild exposure<br>1) Cement--5 bags/cu.yd.<br>2) Water--7 gallons/bag<br>c. Severe exposure<br>1) Cement--7 bags/cu.yd.<br>2) Water--5 gallons/bag<br>3) Using air-entrained cement | 1. Composition of various types of aggregate materials.<br><br>2. Concept of sharp sand and fractured aggregates.<br><br>3. Demonstrate water-cement ratios--observe results of various mixes. |
| 2. Aggregate size and type. | 2. Use maximum size aggregate as determined by size and shape of members, and amount and placing of reinforcing steel.<br>a. One-fifth minimum dimension of members<br>b. Not over three-fourths clear space between reinforcing steel and/or forms.<br>c. Nonreinforced ground slabs not over one-third slab thickness | |
| D. Concrete mixes. | 1. Mild exposure.<br>a. One bag batch<br>1) Sand--3 cu.ft.<br>2) Coarse aggregate--4 cu.ft.<br>3) Water--7 gallons--including water in fine aggregate | |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| b. Total wt. of material for one bag batch / unit wt. of concrete<br>= cu.ft./bag<br>3. Review measures of weight, volume, and percentage | | |
| | | |
| | | |

RELATED CONCEPTS

| INSTRUCTIONAL TOPICS | TECHNICAL CONCEPTS | SCIENCE |
|---|---|---|
| | 2. Normal exposure.<br>a. One bag batch<br>1) Sand--2-1/4 cu.ft.<br>2) Coarse aggregate--3 cu.ft.<br>3) Water--6 gallons--including water in fine aggregate<br><br>3. Severe exposure.<br>a. One bag batch<br>1) Sand--2 cu.ft.<br>2) Coarse aggregate--2-1/2 cu.ft.<br>3) Water--5 gallons--including water in fine aggregate<br><br>4. Trial mix method.<br>a. Selection of constants<br>1) Water-cement ratio<br>2) Aggregate size<br>3) Air content<br>4) Slump range<br>b. Test variables<br>1) Amount of fine aggregate<br>2) Amount of coarse aggregate<br>c. Comparisons of test results | |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| | | |

III. APPLICATION

A. Discuss the various types of cement and show that in most cases bag labeling and material analysis information are the only ways of discerning between one cement and another.

B. Discuss methods of determining the correct concrete mix to use for a given job.

C. Direct students in computing several trial mixes.

D. Design and compute material for the slab or footing which was formed in Unit 3.

IV. EVALUATION CRITERIA GUIDELINE

A. What are the properties of a well-designed concrete mix?

B. Define or explain economy as it refers to a concrete mix.

C. What type mix will an excessive amount of fine aggregate produce? An excessive amount of coarse aggregate?

D. Why must concrete be watertight?

E. What are direct trial mixes?

V. SUMMARY

A. The concrete worker must know and understand the various types of cement available so that he can design, mix, and properly work concrete for optimum results. Concrete mixes vary in many ways and the concrete worker should know how to design a quality mix or order a quality mix. It is important that one know mixes to select for correct usage and also to purchase for economy.

VI. SUGGESTED TIME AND SEQUENCE LISTING

45 minutes -- Introduction and motivation

30 minutes -- Discussion of types of cement

135 minutes -- Practical application--designing concrete mixes
Show film: How to Make Quality Concrete

120 minutes -- Integrated curriculum concepts

30 minutes -- Summary and evaluation

## VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Giese, Henry, A Practical Course in Concrete, Chicago: Portland Cement Association, 33 West Grand Avenue, 1948.

2) Huff, Darrell, How to Work with Concrete and Masonry, New York: Harper & Row Publishers, Inc., 1970.

3) Manual of Concrete Practice--Part I, Detroit: American Concrete Institute, 1968.

INSTRUCTOR'S UNIT PLAN

Unit 6
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Water for Concrete

AIM:

To teach the effects of different waters and impurities in water upon the quality of concrete.

INSTRUCTIONAL AIDS:

Bottled samples of water containing organic materials.

Petrie dishes with decomposing organic materials.

Sample of highly alkaline water.

Sample of highly acid water.

Film - Principles of Quality Concrete, Harrisburg: Modern Talking Picture Service, Inc., J. P. Lilley & Sons, 2009 N. 3rd Street (23 minutes, 16 mm, sound, color).

Transparencies - Teacher-made transparencies with reference to tables used for water analysis and other recording sheets for water analysis.

EQUIPMENT:

16 mm projector, overhead projector, screen.

Filters, litmus paper, Ph test kit, beakers, etc.

Microscope, needed slides, balance.

Mixing container, small compression test mold, testing machine.

PRIMARY REFERENCES:

1) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

2) Concrete Technology--Student Manual, Albany, N. Y.: Delmar Publishers, Inc., 1965.

3) Giese, Henry, A Practical Course in Concrete, Chicago: Portland Cement Association, 33 West Grand Avenue, 1948.

I. INTRODUCTION AND MOTIVATION

A. Have bottles, petrie dishes, and other examples of water with impurities on display. Generate questions and discussion relative to the possible effects of water impurities on concrete.

B. Show film: Principles of Quality Concrete and point out the exactness of control techniques.

C. Proceed with lesson.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Function of water in concrete. | 1. An agent to start the hydration process.<br><br>2. Mobility--the function of water which makes it easier to place concrete.<br>a. 14 to 21 percent per cubic yard<br>b. Quantity used must produce a quality concrete for a specified purpose<br><br>3. Workability--the function of water which enables concrete to be tooled and finished. | 1. Increase in plasticity with increase of water until point of diminishing return is reached.<br>a. Quality of concrete considerations<br><br>2. Concept of Ph. |
| B. Impurities in water and their effects on concrete. | 1. Common materials in solution or otherwise suspended in water used for concrete:<br>a. Sodium chloride and sulfate<br>b. Iron salts<br>c. Alkalis<br>1) Carbonate of sodium<br>2) Carbonate of potassium<br>3) Bicarbonate of sodium<br>4) Bicarbonate of potassium<br>d. Organic materials<br>1) Sewage<br>2) Plant materials<br>a) Swamp water<br>e. Oils<br>f. Algae<br>g. Acid water<br>h. Alkaline water<br>i. Salt or sea water<br><br>2. Effects of impurities on concrete:<br>a. Increase or retard setting time<br>b. Weaken concrete<br>c. Discolor concrete<br>d. Produce efflorescence<br>e. Corrode reinforcement steel | 1. Chemical reactions of impurities and why they affect concrete.<br><br>2. Chemical correction of impure mixing water.<br><br>3. Results of using admixtures to chemically affect setting time, freezing point, etc.<br><br>4. Experiments with increase or decrease in mass of decaying organic matter. Consider gas generation. |
| C. Ascertaining purity or usability of water. | 1. Most natural waters which are suitable for drinking may be used for concrete making.<br><br>2. Tests.<br>a. Water analysis with findings in parts per million (ppm)<br>1) Testing labs<br>2) City or municipal water departments<br>b. Comparing analyses<br>1) With analyses of known acceptable water<br>2) With typical analyses of city water supplies<br>3) Compare with the total ppm of dissolved solids permissible | 1. Testing water for impurities which affect the quality of concrete.<br><br>2. Test run on various concrete mixes which have been prepared with various degrees and types of impurities. |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| 1. Development of the concept of liquid measure.<br><br>2. Volume, weight relationship of water.<br><br>3. Cost computations relating to purchase of water, treating water, etc.<br><br>4. Percentage in terms of cubic yard and other volume proportions. | 1. Reading for understanding:<br>a. Tables<br>b. Charts<br>c. Other literature dealing with determining the acceptability levels of water<br><br>2. Vocabulary development of terms related to water usage in concrete. | 1. Need for and development of water treatment plants.<br>a. Human need--potability<br>b. Ecological aspects<br><br>2. Effects of pollution on water cost and society in general.<br><br>3. Cost of water in arid areas. |
| 1. Calculation of percentage of impurities.<br><br>2. Development of the concept of parts per million (ppm).<br><br>3. Calculation of quantity of admixture to be used. | 1. Recording test data and other analysis data obtained from water tests.<br><br>2. Reading technical data and interpreting the data correctly. | 1. Effects of water testing and sanitation laws or ordinances on society.<br><br>2. Creation of testing laboratories.<br>a. Scientific tests<br>b. Material tests<br>c. Product tests<br><br>3. National Bureau of Standards. |
| 1. Standards or bases of mathematical test formulas.<br>a. Projective techniques | 1. Writing test reports.<br>a. Test description<br>b. Data collection and recording<br>c. Statement of findings<br><br>2. Correct word selection and punctuation as used in technical writing.<br><br>3. Reading manual of test specifications. | 1. Testing agencies and testing standards dealing with water.<br><br>2. Discuss general consumer protection.<br>a. Water<br>b. Food and drugs<br>c. Materials<br>d. Products |

III. APPLICATION

A. Introduce lesson and show film: Principles of Quality Concrete.

B. Discuss the effect of impurities on concrete and have students experiment to ascertain what happens during the decomposing process of organic materials. Test water samples for acidity and alkalinity.

C. Use a basic conrete mix and mix a concrete body using water with various known impurities. Cast test mixes in test molds. Cure test specimens for 28 days and test for compression and shear strength. Tabulate and interpret results of tests.

IV. EVALUATION CRITERIA GUIDELINE

A. Why must the quality of water used for concrete be known?

B. List the effects of at least three impurities, in water, on concrete

C. What affect does algae, in water, have on concrete?

D. What comparison analyses can be used to see if water is satisfactory for concrete?

V. SUMMARY

A. Any impurity in concrete will influence the ultimate strength and durability of the concrete body. However, certain impurities are more injurious than others and therefore, the extent of the impurity concentration, in the mixing water, must be determined. Certain acceptable levels of impurity concentration have been identified and the concrete worker should know these levels and use the information on the job.

VI. SUGGESTED TIME AND SEQUENCE LISTING

40 minutes -- Introduction and motivation

80 minutes -- Science concepts

60 minutes -- Discussion and development of technical concepts

90 minutes -- Preparation and mixing of test samples

60 minutes -- Communications and social studies concepts

30 minutes -- Summary and evaluation

## VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Akroyd, T. N. W., Concrete--Its Properties and Manufacture, Elmsford, N. Y.: Pergamon Press, Inc., 1962.

2) Recommended Practice for Selecting Proportions for Normal Weight Concrete, Detroit: American Concrete Institute, 1969.

INSTRUCTOR'S UNIT PLAN

Unit 7
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Air-Entrained Concrete

AIM:

To familiarize students with the properties and advantages of air-entrained concrete.

INSTRUCTIONAL AIDS:

Slides - Mr. Quality Concrete, Slide #10, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (35 mm, color).

Sample - Bag of air-entrained cement. Several pieces of fractured or broken hardened air-entrained concrete.

EQUIPMENT:

35 mm slide projector, screen.

Microscope, pocket size air indicator.

PRIMARY REFERENCES

1) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

2) Design and Control of Concrete Mixtures, Chicago: Portland Cement Association, 33 West Grand Avenue, 1952.

I. INTRODUCTION AND MOTIVATION

A. Have several microscopes set up and focused on a sample of hardened air-entrained and on normal concrete. Ask students to view the samples and record their impressions of the difference between the two. Draw out the correct answer and question students on the function of the air bubbles. Proceed with the lesson.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Air-entrained concrete. | 1. Principles involved.<br>a. Agent added to produce 400-600 billion of non-connected bubbles in a cubic yard of concrete<br>b. Less water required<br>c. Increases workability in lean mixtures<br>d. Requires less sand<br>e. Bubbles entrap air and block or prevent total filling of bubbles with water<br>f. Entrapped air forms a "cushion" which prevents fracture upon freezing | 1. Examine why bubbles do not totally fill with water.<br><br>2. Examine hydraulic principles. |
| B. Qualities of air-entrained concrete. | 1. Resists freeze-thaw cycles.<br><br>2. Prevents scaling from de-icing chemicals and salt.<br><br>3. When properly adjusted mixes are used there is little, if any, loss of strength when using air-entrained concrete.<br><br>4. Watertightness is increased.<br><br>5. Abrasion resistance is about the same as with normal concrete. | 1. Subject samples of regular and air-entrained concrete to freeze-thaw situations and record results.<br><br>2. Test strength of air-entrained concrete. |
| C. Working properties of air-entrained concrete. | 1. Bubbles produce a "fatty" type feeling to the concrete and increases its mobility.<br><br>2. Bleeding or water separation from paste is decreased.<br><br>3. Can be finished sooner than other concrete.<br><br>4. Aggregates do not separate out of air-entrained concrete.<br><br>5. Air-entrained concrete cannot be excessively agitated or vibrated. | 1. Examine reasons why air-entrained concrete is more easily worked. |
| D. Methods of producing air-entrained concrete. | 1. Portland cement can be purchased with an interground air-entrainment agent.<br>a. Bag identification is:<br>1) Type IA<br>2) Type IIA<br>3) Type IIIA<br><br>2. An admix can be added on the job.<br>a. Admixes<br>1) Vinol resin<br>2) Dorex AEA<br><br>3. Combination of interground and admix. | 1. Identify air-producing or bubble-producing ingredients.<br><br>2. Experiment with increase in gaseous volume produced by admixtures.<br>a. Develop the concept of various states of matter<br><br>3. Boyle's law as it relates to pressure testing. |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| | 1. Write a report on the development of an air-entrained concrete. | 1. Study the development and invention of air-entrained concrete. |
| | 1. Write results of tests conducted under science concepts--interpret data.<br><br>2. Read and interpret specifications for concrete highways. | 1. Investigate the impact of air-entrained concrete on highways, bridges, runways, etc. Consider:<br>a. Initial cost<br>b. Maintenance cost<br>c. Effect of deicers<br>d. Effect of freeze-thaw |
| | | 1. Study changes in working conditions as a result of technological advances in the concrete industry.<br><br>2. Highway development as an equalizer in standards of living in various parts of the U. S. |
| 1. Measurements and weights as they relate to various states of matter.<br><br>2. Ratio as it applies to meter calibration for pressure test equipment. | 1. Vocabulary development relating to air-entrainment, test procedures, and testing methods. | 1. Safety practices as they relate to:<br>a. Materials used in air-entraining<br>b. Pressure test procedures<br>c. Destructive testing |

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| E. Conditions affecting air content. | 1. Size of the aggregate.<br>2. Proportion of water to cement and aggregate.<br>3. As fine aggregate increases, the amount of entrained air increases.<br>4. Amount of admixture influences amount of air-entrainment.<br>5. Amount of vibration will influence the amount of entrained air.<br>6. Increase in concrete temperature decreases entrained air.<br>7. Amount of mixing and speed of mixing influences amount of air-entrainment. | 1. Set up appropriate controls and introduce variables--record results of air-entrainment tests.<br>2. Effect of temperature on air-entrainment. |
| F. Tests for entrained air. | 1. ASTM-C231--pressure method.<br>2. ASTM-C173--volumetric method.<br>3. ASTM-C138--gravimetric method.<br>4. Pocket-size air indicator approximation. | 1. The principles of pressure, volumetric, and gravimetric methods as applied to air-entrainment content. |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| | 1. Reading technical data sheets relating to air-entrainment. | 1. Effect of paving large areas of urban communities.<br>a. Storm sewer systems<br>b. Surface water problems<br>c. Ground water level |
| 1. Unit weight tests.<br>a. Known volume<br>b. Pre-test weight<br>c. Post-test weight<br><br>2. Accurate weighing on precision balances | | 1. Division of labor.<br>a. Laborer<br>b. Skilled concrete worker<br>c. Test technician<br>d. Concrete researcher<br>1) As the technology increases, division of labor tends to increase |

III. APPLICATION

A. Discuss the properties, uses, and advantages of air-entrained concrete.

B. Discuss bubble generating ingredients and show a bag of Type I-A cement. Show various admixtures for air-entraining.

C. Reexamine a slide or sample of air-entrained concrete--show slide #10, Mr. Quality Concrete.

D. Review concrete mix design and develop a mix for formed area in Unit 3 using air-entrained cement.

E. Have students take an entrained air test using a pocket size air indicator.

IV. EVALUATION CRITERIA GUIDELINE

A. Explain why air is entrained in concrete.

B. Explain the principle involved in the quality of air-entraining which enables air-entrained concrete to better resist freeze-thaw situations.

C. Indicate two methods of generating entrained air in concrete.

D. Does air-entrained concrete work differently from regular concrete? Is setting time affected?

V. SUMMARY

A. Air-entrained concrete is used principally to resist freeze-thaw situations and salt scaling. Billions of tiny air bubbles are generated in the cement paste and because of trapped air never completely fill with water. Hence, when the concrete freezes the air can compress to resist rupturing pressures. Air-entrained concrete has increased workability resulting in economy in water, sand, and working time. Air-entrained concrete should not be vibrated excessively since it may release the entrained air.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Introduction and motivation

120 minutes -- Discussion of principles of air-entrainment

120 minutes -- Integrated curriculum concepts

60 minutes -- Practical application review and design of air-entrained concrete mix

30 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Kelly, J. W., Concrete and Mortar, Part 2, Scranton, Pa.: International Correspondence Schools, 1949.

INSTRUCTOR'S UNIT PLAN

Unit 8
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Concrete Working Tools

AIM:

To familiarize the student with the tools most commonly used in concrete work.

INSTRUCTIONAL AIDS:

Slides - Teacher-made slides showing various concrete working tools in operation--concentrate attention on power equipment and other tools too large for shop or classroom.

Transparencies - Teacher-made transparencies showing trowels, hoes, finishing tools, etc. with the nomenclature of the tool indicated.

Pass Out - Copy of Goldblatt Trowel Trades Tool Catalog, available from Goldblatt Tool Company, 511 Osage Street, Kansas City, Kansas 66110.

EQUIPMENT:

35 mm projector, overhead projector, screen, various trowels, finishing tools, floats, levels, and other concrete working tools.

If possible, have pneumatic vibrators, gasoline finishing machines, mixer, etc. available for inspection.

PRIMARY REFERENCES:

1) Cement Makers Manual for Residential Construction, Chicago: Portland Cement Association, 1960.

2) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

3) Concrete Technology--Student Manual, Albany, N. Y.: Delmar Publishers, Inc., 1965.

4) Dalzell, Ralph and Townsend, Gilbert, Masonry Simplified, Vol. I, Chicago: American Technical Society, 1960.

5) Huff, Darrell, How to Work with Concrete and Masonry, New York: Harper & Row Publishers, Inc., 1970.

## I. INTRODUCTION AND MOTIVATION

A. Have on display as many of the tools used for concrete working as possible. After permitting students to examine tools, present slides showing uses of the tools. Have mutilated tools or tools which have been encrusted with concrete due to improper cleaning available and point out differences in tool weight and working quality.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Concrete placement tools and equipment. | 1. Transporting equipment.<br>a. Ready-mix trucks<br>b. Concrete buckets<br>1) Crane lifted<br>c. Chutes and conveyors<br>d. Carts<br>1) Hand powered<br>2) Self-propelled<br>e. Wheelbarrows<br><br>2. Placing equipment.<br>a. Hoes<br>b. Rakes<br>c. Shovels or spades | 1. Mechanical mechanisms using mechanical advantage.<br>a. 1st class levers<br>b. 2nd class levers<br>c. 3rd class levers<br>d. Inclined plane and screws<br><br>2. Principles of sedimentation and alluviation as it applies to concrete and segregation of aggregates from mortar by vibration or long vertical drops. |
| B. Concrete vibrating or compacting equipment. | 1. Hand methods.<br>a. Hoe or rake<br>b. Shovel or spade<br>c. Hand tamper<br><br>2. External vibrators<br>a. Form vibrators<br>b. Surface vibrators<br><br>3. Internal vibrators--inserted into concrete mass.<br>a. Rotary vibrators<br>b. Oscillating or vertical motion<br><br>4. Placement and use of vibrators.<br>a. Horizontal spacing on insertion--18"-30"<br>b. Time--5 to 15 seconds or time to obtain a dense concrete<br>1) Too much vibration causes excessive segregation of aggregate | 1. Principles of flow which result from vibration.<br><br>2. Principles of unbalanced weights or eccentric weights to produce vibration. |
| C. Concrete finishing tools. | 1. Strike off-rod or straight edge.<br>a. To "strike-off" or level concrete to screed grade height<br>b. Materials<br>1) Wood<br>2) Aluminum<br>3) Magnesium<br>c. Sizes<br>1) 1" to 2" thick<br>2) 4" to 6" wide<br>3) 4'-0" to 16'-0" long<br><br>2. Darby--used to remove ridges as a result of the strike-off operation.<br>a. Helps eliminate high and low spots<br>b. Helps prepare a surface for finishing | 1. Forces as they would apply to deflection--both vertically and horizontally to cause change from "straight" in a strike-off rod.<br><br>2. Vibrating principle applied to the darby and bull float to enable development of a surface for finishing.<br>a. Gentle vibration brings a sand cement mixture to the surface<br><br>3. Water resistant qualities of a smooth, dense trowel finish as compared with a float finish. |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| 1. Computing mechanical advantage.<br><br>2. Computing center of gravity as it applies to a loaded cart or wheelbarrow.<br><br>3. Computing volume-weight to determine cart and wheelbarrow loads. | 1. Writing for explanation--e.g., explaining various applications of the three classes of levers or use of the auger (screw) as conveying devices. | 1. The impact of power devices such as the gasoline engine on the concrete industry.<br>a. Manual labor<br>b. Beasts of burden<br>c. Engine driven devices |
| | 1. Building vocabulary as it relates to concrete working equipment. | 1. The relationship between technological advances and larger, stronger structures.<br>a. Mixing devices<br>b. Placement devices<br>c. Vibrating devices<br>As these devices were developed man was able to build larger concrete structures since a stronger more uniformly dense concrete could be placed. |
| 1. Computing expansion and contraction in concrete.<br><br>2. Computing control joint spacing to control crack formation.<br><br>3. Develop the concept of tangent as it relates to corners in concrete working. | 1. Read concrete and mason's catalogs to enable ordering of tools and equipment.<br>a. Stress factual information<br>b. Avoid advertising gimmicks<br>c. Avoid glittering generalities<br><br>2. Write letters to order tools and equipment.<br><br>3. Apply principle of writing to avoid or utilize glittering generalities. | 1. The impact of advertising on contemporary society.<br>a. Human motivation<br>b. Human engineering<br>c. Consumer protection<br><br>2. Discuss technological advances in terms of changing the social order.<br>a. As technology changes so changes society<br>b. Society's control of technology<br>c. Technological change as reflected by art and architecture<br><br>3. Ordinances relating to sidewalks.<br>a. Safety of certain type finishes as compared to other finishes |

RELATED CONCEPTS

| INSTRUCTIONAL TOPICS | TECHNICAL CONCEPTS | SCIENCE |
|---|---|---|
| | 3. Bull float--serves same function as a darby but is larger in size.<br>a. 8" or wider<br>b. Approximately 60" long<br><br>4. Groover or jointer--tool used to cut control joint in fresh concrete.<br>a. Width - 2" to 4"<br>b. Length - 4" to 8"<br>c. Bit length - 3/16" to 1"<br><br>5. Power control joint cutter--gasoline engine or electric powered cutter usually of a saw type.<br>a. Used 4 to 12 hours after concrete sets<br><br>6. Edger--used to produce a radius on the edge or corner of concrete work to produce a better appearance and prevent edge damage.<br><br>7. Floats--used to remove small irregularities and fill small cavities. Usually done prior to steel troweling or may be final finish.<br>a. Types of floats<br>1) Wood<br>2) Cork<br>3) Plastic<br>b. Sizes<br>1) 4"-6" wide<br>2) 12"-16" long<br><br>8. Trowels--used for most final finishes.<br>a. Types<br>1) Steel<br>2) Magnesium<br>b. Sizes<br>1) 3-1/2 to 4-3/4" wide<br>2) 10" to 20" long | |

TO BE DEVELOPED

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
| --- | --- | --- |
| | | |

III. APPLICATION

A. Have students examine tools used for concrete working and develop a "feel" for the tool.

B. Show slides indicating tool nomenclature and other important aspects. Also use slides to indicate basic tool usage. Amplify slide presentation with explanation and "dry run" demonstration.

C. Demonstrate tool usage on prepared fresh concrete or by troweling and finishing sand-lime demonstration and practice mixes. Be sure correct tool cleanup and maintenance practices are presented.

IV. EVALUATION CRITERIA GUIDELINE

A. Have students identify concrete working tools and indicate knowledge of correct nomenclature.

B. Have students indicate proper uses of various tools.

C. Pose various problems in concrete finishing and have students select appropriate tools to obtain desired placement or finishing activity.

D. Why is it necessary that concrete tools be properly cleaned? List correct procedures.

E. Have students demonstrate manipulative ability with tools.

V. SUMMARY

A. To purchase and place concrete is an expensive operation and, therefore, it is important that the material be properly placed, compacted, and finished. The concrete worker must know the correct tools to use so that a quality job will be obtained. Concrete finishing is important since when the concrete hardens it cannot be changed so it is very important that the worker develop the necessary tool skills. Quality of finish and placement is almost in direct proportion to quality of the tools used and hence, tools must be properly cleaned and maintained.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Introduction and motivation

60 minutes -- Presentation of tools and their use

90 minutes -- Integrated curriculum concepts

150 minutes -- Practical application

30 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Brann, D. R., Concrete Work Simplified, Briarcliff Manor, New York: Easi-Bild Pattern Company, 1961.

2) Graham, Frank D., Mason's and Builder's Guide, Vol. 3, Indianapolis: Theodore Audel, 1962.

INSTRUCTOR'S UNIT PLAN

Unit 9
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Estimating the Quantity of Concrete Required for a Given Job

AIM:

To teach how to compute the quantity of concrete required and to reinforce concepts learned in mathematics.

INSTRUCTIONAL AIDS:

Transparencies - Footings and Excavations BC-5, Foundation BC-6, Foundation Plan BC-8, Philadelphia: DCA Educational Products, Inc..

Transparencies - Teacher-made transparencies with various areas and volumes depicted to teach concept of square and cubic measure.

Models - Models of footings, columns, and other geometric solid shapes.

Charts - Various charts with estimating data commonly utilized shown in tabular form.

Blueprints - Prints of a small building with footing details, floor details (concrete) and porch or patio details.

EQUIPMENT:

Overhead projector, screen, chalkboard.

PRIMARY REFERENCES:

1) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

2) Olivio, Mathematics for Masonry Trades, Albany, New York: Delmar Publishers, Inc., 1962.

3) Rising, J. S., Almfeldt and Dejong, Engineering Graphics, Dubuque, Iowa: William C. Brown Company, 1970. 4th Edition.

4) Steinberg, Joseph and Stempel, Martin, Estimating for the Building Trades, Chicago: American Technical Society, 1961.

I. INTRODUCTION AND MOTIVATION

A. Have models representing various geometric shapes which could be utilized for concrete members, e.g., slabs, footing shapes, conical column footings, square and round column shapes, and beam shapes, on display.

B. Use these models to generate discussion relative to how much concrete would be needed to cast the shape.

C. Show blueprints of a building and inquire how one would compute the quantity of concrete required.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Estimating materials for job batching. | 1. Absolute volume of aggregates.<br>a. Actual total volume of all solid aggregates<br>2. Volume of water--actual volume of all water involved in the mix.<br>a. Mixing water<br>b. Water on aggregates<br>3. Apparent specific gravity. | 1. Specific gravity.<br>2. Apparent specific gravity.<br>3. Weight of water. |
| B. Computing amount of concrete required. | 1. Basic unit of measure.<br>a. Cubic yard which equals 27 cubic feet<br>2. Volume basically in length times width times depth or area times depth.<br>a. Irregular shapes have constants to compute depth<br>b. Irregular shapes may have constants to compute area rather than depth<br>3. Cubic yard.<br>a. Cubic yard = $\frac{\text{length (ft) x width (ft) x thickness (ft)}}{27}$<br>4. Reducing compound geometric solids to simple geometric solids.<br>5. Computing overage (5-10%) for error and waste. | 1. Discussion of the metric system of measurement. |
| C. Short cuts in estimating concrete. | 1. Use of tables.<br>a. Tables have precomputed amounts<br>b. Graphical representation<br>1) N charts<br>2) Z charts | |
| D. Use of concrete calculators. | 1. Circular and slide type calculators.<br>a. Approximations not totally accurate<br>b. Only as accurate as the quality of printing gradations<br>2. Excellent for quick estimates or to check computed estimates. | |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| 1. Computation of absolute volume.<br>a. Absolute volume equals the unit weight of the material divided by the apparent specific gravity times the unit weight of water (62.5 lbs. per cubic foot)<br>b. A.V. = $\frac{UW}{A.S.G. \times 62.5}$<br>c. Apparent specific gravity (approx.)<br>1) Cement--3.1<br>2) Sand--2.65<br>3) Aggregate--2.65 | 1. Building vocabulary and understanding as it relates to volume, geometric shapes, and geometric solids. | 1. The use of geometric shapes in some of the more notable structures of the world.<br>a. Pyramids<br>b. St. Paul's in Rome<br>c. Etc.<br><br>2. Study of selected mathematicians and their contributions. |
| 1. Computation of volume as it relates to all types of geometric shapes.<br><br>2. Reduction of compound geometric solids to simple or single solids to enable computation of volume.<br><br>3. Changing inches to fractional part of a foot.<br><br>4. Changing inches or feet and inches to decimal equivalents. | | 1. Changing to the metric system in the U. S.<br>a. Pro<br>b. Con<br>c. Economic aspects<br>d. Long range effect |
| | 1. Reading nomograms, Z charts and N charts.<br><br>2. Reading other technical charts and literature used in computation of quantity. | |
| 1. Use of slide rules and other calculating devices. | 1. Locating sources of information.<br>a. Methods used<br>b. Communicating exactly what you want to know orally and written | |

III. APPLICATION

A. Develop the concept of a cubic yard, cubic foot, etc. as a basis for quantity computations.

B. Discuss and demonstrate how to estimate the quantities of cement, fine aggregate, coarse aggregate, and water required to produce a cubic yard of concrete. Have students work problems.

C. Discuss and demonstrate how to compute or estimate the volume of concrete required for selected shapes and problems.

D. Practical application--have students reduce model shapes to geometric forms enabling volume computations. Extract quantities of concrete required from blueprints. Compute quantity of concrete required for formed area in Unit 3.

IV. EVALUATION CRITERIA GUIDELINE

A. What is meant by a cubic yard of concrete?

B. What is absolute volume?

C. State the basic formula used to compute rectilinear concrete requirements.

D. Explain the use and reliability of concrete calculators.

V. SUMMARY

A. Estimating the quantity of batch materials and the volume of concrete required for a given job is an important duty of the concrete worker. The amount of concrete, in terms of cubic yards, is the measure most frequently used. Workers must be able to compute area and thickness to cubic yards and also be able to reduce complex shapes to basic geometric solids to enable computation of cubic content.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Introduction and motivation

120 minutes -- Math concepts

60 minutes -- Integrated curriculum concepts

105 minutes -- Practical application--estimate formed area from blueprints

45 minutes -- Summary and evaluation

## VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Giese, Henry, A Practical Course in Concrete, Chicago: Portland Cement Association, 33 West Grand Avenue, 1948.

2) Olivio, Basic Mathematics Simplified, Albany, New York: Delmar Publishers, Inc., 1962.

INSTRUCTOR'S UNIT PLAN

Unit 10
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Mixing Concrete

AIM:

To teach how to mix concrete by hand and small mixer methods.

INSTRUCTIONAL AIDS:

Film - Principles of Quality Concrete, Harrisburg: Modern Talking Picture Service, Inc., J. P. Lilley & Sons, 2009 N. 3rd Street (23 minutes, 16 mm, sound, color).

Film - Concrete Example, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (16 minutes, 16 mm, sound, color).

Slides - Teacher-made slides showing hand mixing methods and various types of small mixers.

EQUIPMENT:

16 mm projector, slide projector, screen.

Concrete mortar box, materials for mixing concrete, hoe, square point shovel, small mixer.

PRIMARY REFERENCES:

1) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

2) Graham, Frank D., Masons' and Builder's Guide, Vol. 3, Indianapolis: Theodore Audel, 1962.

3) Huff, Darrell, How to Work with Concrete and Masonry, New York: Harper & Row Publishers, Inc., 1970.

I. INTRODUCTION AND MOTIVATION

A. Have students experiment, feel, and classify sand as dry, wet, or very wet. Pull hoe through the coarse aggregate to get an idea of the amount of resistance. Show film: Concrete Example.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Review of concrete materials. | 1. Cement--use the right type and correct proportion of concrete.<br>a. Do not use hard, lumpy cement.<br><br>2. Aggregates--use maximum allowable size for the job.<br>a. Coarse aggregate--hard and clean<br>b. Fine aggregate uniformly sized and clean<br><br>3. Water--use the correct amount of clean quality water.<br><br>4. Admixtures--when needed use the correct type and amount for the job. | 1. Concept of quality control of concrete materials. |
| B. Hand mixing. | 1. Carefully measure correct proportions of ingredients as determined by the mix design. Consider water in sand.<br>a. Dry sand--0% water--seldom available<br>b. Damp sand--1/4 gal. water per cu. ft.<br>c. Wet sand--1/2 gal. water per cu. ft.<br>d. Very wet sand--3/4 gal. water per cu. ft.<br><br>2. Dry mixing--thoroughly mix dry concrete until all materials are uniformly distributed.<br>a. Work back and forth in mortar bed until uniform mix is obtained<br><br>3. Add water--in a cavity formed with the hoe at one end of the bed add about 50% of the water. "Cut" the dry material into the mix and thoroughly mix. Add more water and repeat mixing. | |
| C. Small mixer batches | 1. Types of small mixers.<br>a. Mixer-wheelbarrow combination<br>b. Small tumble mixers<br>1) 1/2 to 2 bag size<br>2) 3 or 4 tumble blades<br><br>2. Barrel power--the mixer barrel may be driven by electric motor or gasoline engine.<br><br>3. Mixer should be clean and in good condition.<br>a. Worn blades or concrete encrusted blades reduce mixing efficiency | 1. Corrosive action of various materials used in admixtures.<br><br>2. Concept of centrifugal force and mixer action. |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| 1. Review of sizing of materials.<br><br>2. Review proportion, volume, etc. | 1. Reading and interpreting admixture directions.<br><br>2. Determining correct admixture to use from product literature. | |
| | | 1. Labor requirements when hand methods are used.<br><br>2. Development of work standards.<br><br>3. Development of protective laws regarding man and work. |
| 1. Determining revolutions per minute (rpm) as it relates to mixer rotation speed.<br><br>2. Speed reduction from various pulley or gear combinations--diameter circumference situations. | 1. Reading operating instructions for mixers.<br><br>2. Reading safety rules relating to mixers, etc.<br><br>3. Reading maintenance directions. | 1. Labor savings with mechanized equipment.<br><br>2. Concept of division of labor brought about by mechanization.<br><br>3. Changes in hours of work and working conditions. |

RELATED CONCEPTS

| INSTRUCTIONAL TOPICS | TECHNICAL CONCEPTS | SCIENCE |
|---|---|---|
| | 4. Procedure.<br>a. Prepare proportions<br>b. Put approximately 10% of required water in mixer<br>c. Add mix materials<br>d. Add 80% of remaining water<br>e. Mix at least one minute<br>f. Add remaining water<br>g. Mix at least three minutes | |
| D. Cleaning equipment. | 1. Flush with water.<br>2. Scrape any hardened concrete from surfaces.<br>3. Flush with water.<br>4. Lightly oil or wax.<br>5. Cleansing agents.<br>a. Mild vinegar solution (10% acetic acid)<br>b. Commercial cleaners | 1. Action of acids on concrete and cement materials.<br>2. Composition of commercial cleaners.<br>3. Safety with acids, caustics, etc. |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| | | 1. Safety regulations and rules relating to acids, etc. |

III. APPLICATION

A. Discuss materials used. Explain dry, damp, wet, and very wet sand.

B. Explain tool names and nomenclature--note condition and cleanliness of tools.

C. Have students measure quantities of material for a small batch of the mix designed in Unit 5. Compute usable quantity for pouring all or part of formed area in Unit 3.

D. Place materials in mortar box or bed--dry mix--then add water and complete mix. Demonstrate correct procedures.

E. Show film: Principles of Quality Concrete. Repeat C above for a batch in a small mixer. Demonstrate correct procedures. Mix.

F. Place concrete in forms placed in Unit 3. Apply appropriate finish. Have students observe finishing methods.

G. Demonstrate correct method of cleaning tools and equipment. Have students clean equipment.

IV. EVALUATION CRITERIA GUIDELINE

A. Have students list materials used for making concrete.

B. Why is water quality of importance?

C. Explain how to hand mix concrete--same for small mixer.

D. Explain how to clean tools and equipment. Indicate importance of this operation.

V. SUMMARY

A. Concrete is a mixture of portland cement, inert materials (aggregates) and water. The cement forms a semifluid paste which must completely cover the aggregate material. Hence, correct mixing procedures are of great importance if a quality concrete is to be produced. Concrete workers must know correct mixing procedures. Also, since hardened concrete is difficult or impossible to remove from tools and equipment, the worker must know correct cleaning procedures.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Introduction and motivation. Show film: Concrete Example

75 minutes -- Integrated curriculum concepts

105 minutes -- Practical application--mixing concrete

120 minutes -- Practical application--finishing demonstration

30 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Cement Mason's Manual for Residential Construction, Chicago: Portland Cement Association, 33 West Grand Avenue, 1960.

2) DeCristoforo, R. J., Handy Man's Concrete and Masonry Handbook, New York: Arco Publishing Company, Inc., 1960.

3) Giese, Henry, A Practical Course in Concrete, Chicago: Portland Cement Association, 33 West Grand Avenue, 1948.

4) Recommended Practices for Measuring, Mixing, and Placing Concrete, Bulletin 614-59, Detroit: American Concrete Institute, 1959.

INSTRUCTOR'S UNIT PLAN

Unit 11
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Testing Concrete

AIM:

To teach basic concrete tests and reinforce knowledge of concrete mixes.

INSTRUCTIONAL AIDS:

Film - Soil--Cement Inspection and Field Control, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (17 minutes, 16 mm, sound, color).

Transparencies - Teacher-prepared transparencies on various tests (diagram type section views). Transparencies on recording test data and its interpretation (tally forms, computation, etc.).

EQUIPMENT:

16 mm projector, overhead projector, screen.

Test cylinder, slump cone, tamping rod, compression test mold, rule, shovel, compression test machine, microscope.

PRIMARY REFERENCES:

1) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

2) Sampling and Testing Ready-Mixed Concrete, Silver Spring, Md.: National Ready Mixed Concrete Association, Latest Edition.

3) Standards on Concrete and Concrete Materials, Philadelphia: American Society for Testing Materials, 1970.

I. INTRODUCTION AND MOTIVATION

A. Have hardened samples of quality concrete on display and also samples which evidence failures of various types. Show film: Soil--Cement Inspection and Field Control. Discuss need for quality control and proceed with the lesson.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Testing in industry and the construction trades. | 1. Testing as an integral part of industry and construction.<br>a. Material testing<br>b. Product testing<br>1) Function<br>2) Durability<br>3) Safety<br>c. Nondestructive testing<br>d. Destructive testing | 1. Safety factors as they relate to building construction and other uses of concrete. |
| B. Sampling. | 1. Importance of sampling techniques.<br>a. ASTM-C172--Standard Method of Sampling Fresh Concrete<br>2. Sample size of sample.<br>a. Strength tests<br>b. Slump tests<br>3. Procedures for:<br>a. Stationary mixers<br>b. Paving mixers<br>c. Revolving drum truck mixers<br>d. Open top mixers | 1. Representative sampling.<br>a. Impartiality<br>b. Accuracy<br>c. Adherence to standards |
| C. Consistency tests. | 1. Slump test.<br>a. ASTM-C143--Standard Method of Slump Test for Consistency of Portland Cement Concrete<br>b. Accuracy and use of the test<br>c. Equipment used<br>1) Slump test mold or slump cone<br>2) Steel or flat plate<br>3) Cone rod<br>4) Rule<br>d. Procedure<br>1) Sampling<br>2) Cone preparation<br>3) Cone placement<br>4) Cone holddown<br>5) Mold filling steps<br>6) Rodding procedure<br>7) Strike-off<br>8) Removing cone mold<br>9) Measuring slump<br>10) Interpreting results<br>2. Ball penetration test.<br>a. ASTM-C360--Tentative Method of Test for Ball Penetration in Fresh Portland Cement Concrete<br>b. Ball size and weight<br>c. Procedure<br>1) Sample and size<br>2) Placement of ball<br>3) Measurement<br>4) Interpreting results | 1. Penetration of ball into materials of different consistencies and densities.<br>a. Concept of hardness testing<br>2. Review of specific gravity as it relates to concrete materials' weight. |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| 1. Computation of safety factors.<br>a. Allowable load<br>b. Safe load<br>c. Safety factor load<br><br>2. Mathematical comparisons. | 1. Development of vocabulary.<br>a. Sample<br>b. Material testing<br>c. Nondestructive testing<br>d. Destructive testing<br>e. Allowable load<br>f. Safety factor<br>g. Kips | 1. The mass production process<br>a. Interchangeability of parts<br>b. Need for quality control |
| 1. Types of samples.<br>a. Random<br>b. Frequency<br>c. Selected<br>d. Etc. | | |
| 1. Review measurement.<br>a. Linear<br>b. Volumetric<br>c. Avoirdupois<br><br>2. Compute percentages of slump. | 1. Read and interpret test results in Consumer's Report.<br>a. Write paper on why a certain product was selected | 1. Origination and development of the National Bureau of Standards.<br>a. National aspects<br>b. International aspects<br><br>2. Development of independent testing laboratories.<br>a. Good Housekeeping<br>b. Consumer's Report<br>c. Underwriter's Lab.<br>d. American Society for Testing Materials |

RELATED CONCEPTS

| INSTRUCTIONAL TOPICS | TECHNICAL CONCEPTS | SCIENCE |
|---|---|---|
| | 3. Unit weight test.<br>a. ASTM-C138--Standard Method of Test for Air Content of Freshly Mixed Concrete by Gravimetric Method<br>b. Sample and size<br>c. Procedure<br>d. Interpretation of results | |
| D. Strength or follow-up tests. | 1. Compressive tests.<br>a. ASTM-C31--Standard Method of Making and Curing Concrete Compression and Flexural Test Specimens in the Field<br>b. ASTM-C39--Standard Method of Test for Compressive Strength of Molded Concrete Cylinders<br>c. Sample and size<br>d. Procedure<br>e. Curing<br>f. Shipping to laboratory<br>g. Interpreting test results<br><br>2. Flexural tests.<br>a. Same material as for compressive tests except for appropriate procedural change | 1. Methods of compressive testing.<br>a. Safety<br><br>2. Methods of flexural testing.<br>a. Elasticity<br>b. Modulus of elasticity<br>c. Frequency |
| E. Tests for entrained air. | 1. Pressure method.<br>a. ASTM-C231--Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method<br>b. Used for all concrete except highly porous and lightweight aggregate concrete.<br><br>2. Volumetric method.<br>a. ASTM-C173--Standard Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method<br>b. Useful for highly porous and lightweight aggregate concrete.<br><br>3. Gravimetric method.<br>a. ASTM-C138--Standard Method of Test for Air Content of Freshly Mixed Concrete by the Gravimetric Method<br>b. Must know specific gravities and absolute volumes of concrete | 1. Principles related to air pressure and use of pressure in testing.<br><br>2. Principles of displacement as related to volumetric method of air-entrainment testing.<br>a. Air as matter occupies space |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| | | |
| 1. Computations related to strength of materials. | 1. Reading, writing, interpreting, and vocalizing test results. | 1. Safety standards relating to use of concrete in buildings and other structures.<br>a. Safety factors<br>b. "Fireproof" buildings |
| 1. Computation of concrete yield by the unit weight method--ASTM-C138.<br>a. Volume produced = $\frac{\text{wt. of ingredients}}{\text{weight per cu.ft. of concrete}}$<br>2. Computation of percent of air in air-entrained concrete.<br>a. Percent of air = $\frac{\text{theoretical unit wt. - measured unit wt.}}{\text{theoretical unit weight}}$ | 1. Explaining the principle of air-entraining and its function to a lay person. | |

RELATED CONCEPTS

| INSTRUCTIONAL TOPICS | TECHNICAL CONCEPTS | SCIENCE |
|---|---|---|
| | 4. Simple field tests for air content.<br>a. Unit weight test<br>1) Measures change in a given amount of material on basis that increased air lessens weight<br>b. Pocket-size air indicator<br>1) Approximate measure<br>2) Principle of displacement and then loss of volume with loss of air | |

TO BE DEVELOPED

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
| --- | --- | --- |
| | | |

III. APPLICATION

A. Introduce the concept of quality control and the need for care in performing tests.

B. Introduce, discuss, and execute a consistency test.

C. Introduce, discuss, and execute a yield test.

D. Introduce, discuss, and execute a compression test.

E. Integrated concepts.

IV. EVALUATION CRITERIA GUIDELINE

A. Explain the value of a slump test.

B. When one slump differs from another what does it indicate?

C. Explain how to execute an air-entrainment test with a pocket air indicator.

D. Describe a basic compression test procedure--include sampling, molding, curing, testing, and interpreting results.

E. Why is quality control important?

V. SUMMARY

A. Concrete mixes are designed to do a particular quality job at a specified cost. Therefore, concrete users specify the type mix they desire. To assure quality control, certain tests are executed while the concrete is fresh or plastic. The American Society for Testing Materials has established tests and standards to be followed. The concrete worker should know these tests and how to execute them.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Introduction and motivation

120 minutes -- Demonstrating various tests

60 minutes -- Integrated curriculum concepts

120 minutes -- Practical application--making tests, slump, air content and preparation of compression test samples

30 minutes -- Summary and evaluation

## VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963, ASTM Publications, pages 110 and 114.

2) Design and Control of Concrete Mixtures, Chicago: Portland Cement Association, 33 West Grand Avenue, 1952.

3) Manual of Concrete Practices, Vol. I, American Concrete Institute, 1968.

INSTRUCTOR'S UNIT PLAN

Unit 12
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Formwork and Forming Concrete

AIM:

To teach basic formwork construction and acquaint students with materials used for forms.

INSTRUCTIONAL AIDS:

Film - How to Build New Shapes in Concrete, Harrisburg: Modern Talking Picture Service, Inc., J. P. Lilley & Sons, 2009 N. 3rd Street (18 minutes, 16 mm, sound, color).

Film - New Shapes in Concrete, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (16-1/2 minutes, 16 mm, sound, color).

Film - New Developments in Slip Form Paving, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (14 minutes, 16 mm, sound, color).

Transparencies - Teacher-made transparencies showing how various types of forms are constructed, e.g., slab forms, stepped footings, curb forms, steps, etc.

EQUIPMENT:

16 mm projector, overhead projector, screen.

Tools for constructing forms--hammers, saws, level, rules, squares, transit, etc.

Materials--appropriate 2 x 4's, 1 x 6's, 1 x 8's, etc. as required by unit being formed.

PRIMARY REFERENCES:

1) Concrete Basements for Homes, Chicago: Portland Cement Association, 33 West Grand Avenue, 1965.

2) Concrete Form Construction, Albany, New York: Delmar Publishers, Inc., 1965.

3) Wagner, Willis H., Modern Carpentry, Homewood, Ill.: Goodheart-Willcox Company, Inc., 1967.

I. INTRODUCTION AND MOTIVATION

A. Show film: New Shapes in Concrete and use film content to elicit discussion relative to need for forms to contain concrete until it attains hardened strength. Discuss what would occur if forms were not properly constructed and proceed with lesson.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Principles of form construction. | 1. A well-designed form should:<br>a. Be easily erected<br>b. Be easily stripped<br>c. Be readily plumbed or leveled<br>d. Be rigid enough to withstand pressures of concrete<br>e. Enable reuse of material<br>f. Provide means for removing debris from formed area | |
| B. Pressures from concrete, materials for forms, footing and sidewalk forming. | 1. Review material from Unit 3.<br>2. Relate this information to formwork in general. | |
| C. Forming for walls and bulkheads. | 1. Form sheathing.<br>a. Exterior plywood<br>b. Form plywood<br>1) Thicknesses<br>2) Oiling<br>2. Stiffing studs or uprights.<br>a. 2" x 4" fir<br>b. Spacing<br>3. Whalers.<br>a. Longitudinal supports<br>b. Material size<br>1) 2" x 4" fir<br>2) 2 x 2 x 4" fir<br>3) 4" x 4" fir<br>c. Spacing<br>4. Braces<br>a. Material<br>1) 2" x 4" fir<br>2) 1" x 6" yellow pine<br>b. Spacing<br>1) At studs or uprights<br>2) Intermediate<br>5. Stakes<br>a. Material<br>1) 2" x 4" fir<br>2) 1" x 4" yellow pine<br>b. Driving stakes<br>1) Angle<br>2) Method<br>6. Nailing forms.<br>a. Nail type<br>b. Bracing against vibration when nailing | 1. Coatings and surface treatments to aid in release of forms from hardened concrete. |
| D. Forming steps. | 1. Computing rise and run.<br>a. Safety aspects<br>b. Rise-tread combination figures<br>1) 17-1/2" preferred<br>2) 17-1/2" to 20" acceptable | 1. Force vectors, bracing angles, etc. as they relate to placing stakes and braces for formwork. |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| | 1. Write review paper on forming methods, materials covered in Unit 3. | 1. Discuss the federal highway system.<br>a. Function<br>b. Financing<br>c. Regulating factors |
| | | |
| 1. Application of stiffness formula.<br>a. Stiffness = depth squared<br>1. $S = d^2$<br>b. Where d equals the width of a board for a given thickness | 1. Exercises in giving concise, clear orders to others.<br>a. As worker-helper<br>b. As foreman<br><br>2. Reading safety regulations relating to concrete forming practices. | 1. Human factors in building design.<br>a. Function<br>b. Aesthetics<br><br>2. Worker relationships.<br>a. Getting along on the job<br>b. Cooperation<br>c. Leadership-followership characteristics |
| 1. Computation of total rise and total run.<br><br>2. Computation of riser-tread ratios and safe riser height.<br><br>3. Cost of time lost accidents. | 1. Building vocabulary relating to formwork.<br>a. Whalers<br>b. Studs<br>c. Spacers<br>d. Tie bars<br>e. Overhang<br>f. Etc. | 1. Safety regulations as they relate to steps.<br>a. FHA Regulations<br>b. Ramps, etc. for handicapped persons<br>1) Federal and state regulations<br><br>2. Workmen's Compensation. |

RELATED CONCEPTS

| INSTRUCTIONAL TOPICS | TECHNICAL CONCEPTS | SCIENCE |
|---|---|---|
| | 2. Cheek or sidewall forming<br>a. Material<br>1) Plywood types<br>2) 1" solid wood<br><br>3. Forming for overhang or indented panels.<br>a. Amount of overhang<br>b. Method of forming<br><br>4. Riser forming.<br>a. Material size<br>1) 2" x height of riser<br>2) 1" x height of riser<br>b. Beveling bottom edge to enable complete tread finishing<br>c. Riser placement<br>1) Perpendicular<br>2) Angled<br>3) Tread overhang<br><br>5. Nailing and staking procedures.<br>a. Apply principles used for walls | |
| E. Forming columns and piers. | 1. Sheathing materials<br>a. Plywood<br>b. Solid 1" x 8" or 10"<br><br>2. Studs or uprights<br>a. 2" x 4" fir<br>b. Spacing<br><br>3. Yoke placement and size.<br>a. Pressure computation<br>b. 2" x 4", 3" x 4", 4" x 4" fir<br>c. Use of spreaders<br>d. Use of tie bolts<br><br>4. Corner treatment.<br>a. Fillets<br>b. Bevels and chamfers<br><br>5. Reinforcement clearance.<br>a. Aggregate size ratio<br>b. 3" minimum | |
| F. Commercial forms. | 1. Material usually steel.<br><br>2. Various types and fastening techniques are available.<br>a. Consult various supply catalogs for examples<br><br>3. Treated fiberboard forms.<br>a. Circular<br>b. Irregular shape<br><br>4. Various floor and ceiling pans.<br>a. Corrugated<br>b. Vee beam<br>c. Pan and beam | 1. Methods and procedures used to produce hardboard and fiberboard.<br>a. Lignin binders<br>b. Resin binders |

TO BE DEVELOPED

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| | | 3. Legal limits and other aspects of administering first aid. |
| | | 1. Consider relative value of equipment that is well-cleaned and maintained with equipment not cleaned and which deteriorates rapidly. |
| 1. Figuring cost and depreciation of metal or commercial forms. | 1. Reading literature and directions for use of commercial form and accessories.<br><br>2. Explaining how to assemble various types of form systems. | |

III. APPLICATION

A. Introduce topic and generate an understanding of the need for strong, accurate formwork.

B. Utilize transparencies to explain various types of form construction--use chalkboard to amplify concepts.

C. Have students sketch form structures for selected problems.

D. Practical application--if possible, have students construct forms for concrete work which will be completed. If this cannot be done, have students construct various forms on lawn or other work area. Build forms for splash blocks, lawn benches, birdbaths or other similar structures.

IV. EVALUATION CRITERIA GUIDELINE

A. List characteristics of a well-designed form.

B. How are controls developed? Is forming ever unnecessary?

C. How are overhangs or panels formed.

D. Why must stakes be properly driven and aligned.

V. SUMMARY:

A. Fresh concrete is a semifluid or plastic material and must be contained in a form of some type for most uses. The forms must be accurately constructed to proper grade, proper dimensions, and proper shape. Forms must also be constructed in a manner that provides enough strength to withstand the pressure of the plastic concrete. When hardened, concrete cannot be readily moved so the concrete worker or carpenter who constructs the forms must work accurately.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Introduction and motivation

60 minutes -- Integrated curriculum concepts

60 minutes -- Developing concepts and knowledge about forming

180 minutes -- Practical application--construction of step form, column forms, or forms of benches, birdbaths, etc.

30 minutes -- Summary and evaluation

## VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Formwork for Concrete, Detroit: American Concrete Institute, 1969.

2) Spence, William P., Architecture--Design, Engineering, Drawing, New York: McKnight & McKnight Publishing Company, 1967.

INSTRUCTOR'S UNIT PLAN

Unit 13
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Reinforcing Concrete

AIM:

To familiarize students with the basic principles of concrete reinforcement and to present basic reinforcement methods.

INSTRUCTIONAL AIDS:

Film - Constructing a Prestressed Concrete Building, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (11-1/2 minutes, 16 mm, sound, color).

Slides - Ultimate Strength Design, Lecture Notes and 2" x 2" Slides, Detroit: American Concrete Institute, Publications Department Box 4754.

Slides - Teacher-made slides of reinforcing in place. Show reinforcing members, temperature members, and tying techniques.

Transparencies - Teacher-made, showing forces on a beam in various configurations and the location of reinforcement rods.

EQUIPMENT:

16 mm projector, 35 mm slide projector, overhead projector, screen.

Various size reinforcing rods, reinforcement accessories, tying wire and wire fabric.

Hammers, bending devices, pliers, shears, hacksaw.

PRIMARY REFERENCES:

1) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

2) Dunham, Clarence W., The Theory and Practice of Reinforced Concrete, New York: McGraw-Hill Book Company, 1966.

3) U. S. A. Standard Recommended Practice for Manufacturing Reinforced Concrete Floor and Roof Units, Detroit: American Concrete Institute, 1967.

## I. INTRODUCTION AND MOTIVATION

A. Have several small cast sections of concrete, each about 1" diameter and 12" long, and have students try to pull them apart. Repeat operation with a reinforced piece of the same dimensions, using a 1/8" diameter, deformed wire as reinforcement. Show film: Constructing a Prestressed Concrete Building. Proceed with body of lesson.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Strength of concrete. | 1. Forces or types of loads placed on concrete.<br>a. Compressive<br>b. Tensile<br>c. Torsion--rarely will this force be present and actually it is a combination of tension and compressive forces<br><br>2. Concrete has great strength in compression.<br><br>3. Concrete is low in tensile strength. | 1. Development of an understanding of:<br>a. Compressive strength<br>b. Tensile strength<br>c. Torsion strength<br><br>2. Experiments to help develop ability to identify types of forces acting on a structure.<br>a. Forces on a cylinder<br>b. Forces on a beam or lintel |
| B. Purpose of reinforcement. | 1. Reinforcement increases concrete's ability to withstand tension forces.<br>a. Strength of reinforcement members<br>b. Strength of total unit<br><br>2. Proper reinforcement design enables the tensile strength to be made to equal or exceed the compressive strength of concrete. | 1. Develop a concept of strength and properties of materials.<br>a. Compressive strength<br>b. Tensile strength<br>c. Hardness<br>d. Brittleness<br>e. Ductility<br>f. Malleability<br>g. Etc. |
| C. Material commonly used for reinforcement. | 1. Steel is the most accepted material for reinforcement.<br>a. Strength of steel<br>b. Cost of steel<br>c. Similarity of expansion and contraction<br>d. High strength steel<br><br>2. Forms of reinforcement material.<br>a. Smooth rods<br>b. Deformed rods<br>c. Welded wire fabric<br>d. Reinforcement rods bent to shape and welded<br><br>3. Reinforcement accessories.<br>a. Slab bolster<br>b. Bar chair<br>c. High chair<br><br>4. Sizing of reinforcement materials.<br>a. Sizes of reinforcing rods are designated by numerals 1) #2 = 1/4", #3 = 3/8" and so on by 1/8" increments<br>b. Welded wire fabric is indicated by wire gage number and wire spacing | 1. Principles involved in rod deformation.<br>a. Adhesion<br>b. Cohesion<br>c. Resistance<br>d. Lug size<br>e. Lug spacing |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| 1. Computations relating to beam loading.<br>a. Simple equations with one unknown<br>b. Load bearing area | 1. Reading lintel and other concrete beam allowable load tables.<br>a. Permissible spans<br>b. Spacing requirements<br>c. Minimum load | 1. Building codes, licensing procedures and other governmental safeguards as related to public buildings and other structures. |
| | 1. Build vocabulary in relation to reinforcement.<br>a. Reinforcement<br>b. Deformed rod<br>c. High chair<br>d. Tension<br>e. Compression<br>f. Etc. | 1. Famous concrete structures.<br>2. Architects and their creations.<br>3. Use of concrete for aerospace launch pads, missile silos, etc. |
| 1. Use of numerals to designate rod diameters.<br>2. Use of wire gage sizes.<br>3. Weight diameter ratios. | | |

RELATED CONCEPTS

| INSTRUCTIONAL TOPICS | TECHNICAL CONCEPTS | SCIENCE |
|---|---|---|
| D. Placement of reinforcing steel. | 1. Large jobs or structures which are heavily loaded should be designed by a structural engineer.<br><br>2. General rule of placement is to put reinforcement on side opposite the force--i.e., where concrete is in tension.<br><br>3. Concrete coverage over reinforcing steel use.<br>a. Follow ACI-318 Building Code Requirements for Reinforced Concrete<br><br>4. Splicing reinforcement steel.<br>a. Overlap at least 24 rod diameters<br>b. Minimum lap is 12"<br><br>5. Splicing welded wire fabric.<br>a. Overlap one full wire spacing plus 2"<br><br>6. Reinforcement steel must be free of rust, paint, etc.<br><br>7. Reinforcing steel must be accurately placed according to specifications and blueprints.<br>a. Properly tie rods in place<br>b. Use appropriate accessories | 1. Principles involved in the amount of concrete covering reinforcing steel.<br>a. Maximum aggregate size and reinforcement spacing |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| 1. Measurement for placing reinforcement steel.<br>a. Multiple spacing<br>b. Multiple rod diameters<br>c. Height spacing<br>d. Control rod spacing | 1. Reading reinfrocement specifications and blueprints.<br><br>2. Reading three dimensional drawings. | 1. Education and training requirements for structural engineering.<br>a. Licensing procedures<br>b. Responsibilities |

III. APPLICATION

A. Develop an understanding of the strength properties of concrete.

B. Demonstrate the principles of reinforcement, reasons for reinforcement, and placing of reinforcement.

C. Build a beam mold and cast nonreinforced and reinforced beams--properly cure beams and subject them to tests.

D. Wire mock-up reinforcing rod structures for various purposes.

E. Place welded wire fabric in a mock-up or real form--consider height of fabric and edge clearance.

IV. EVALUATION CRITERIA GUIDELINE

A. Explain reinforcement.

B. Explain how welded wire fabric helps control cracking of concrete.

C. Explain how to lap concrete reinforcing rods and wire fabric.

D. What is the difference between compression and tension?

E. Explain how tension forces work on a concrete cylinder.

F. Explain the forces acting on a top loaded beam.

V. SUMMARY

A. Concrete, as a structural material, is very strong in compression but does not have much strength in tension. When properly designed steel reinforcement is added to concrete structures, the structural strength of concrete, in tension, can be made to equal or exceed the compressive strength. Reinforcement also helps to equalize the forces of expansion and contraction and thus aids in crack control. The concrete worker must know how to place reinforcement and properly work the concrete around the reinforcement steel.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Introduction and motivation. Show film: Constructing a Prestressed Concrete Building

90 minutes -- Discuss principles of reinforcement. Use slides: Ultimate Strength Design

60 minutes -- Integrated curriculum concepts

150 minutes -- Practical application--wire mock-ups, place fabric, and cast beams

30 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Building Code Requirements for Reinforced Concrete, ACI-381, Detroit: American Concrete Institute, 1965.

2) Giese, Henry, A Practical Course in Concrete, Chicago: Portland Cement Association, 33 West Grand Avenue, 1948.

3) Huff, Darrell, How to Work with Concrete and Masonry, New York: Harper & Row Publishers, Inc., 1970.

INSTRUCTOR'S UNIT PLAN

Unit 14
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Joints, Joining and Crack Control

AIM:

To familiarize students with joints and details, joining techniques, and methods of crack control.

INSTRUCTIONAL AIDS:

Film - Better Dummy Joints, Washington, D. C.: United States Army Engineers (9 minutes, 16 mm, sound, color).

Film - Construction of a Concrete Industrial Floor on the Ground, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (32-1/2 minutes, 16 mm, sound, color).

Slides - Mr. Quality Concrete, Slides #34 to #38 Inclusive, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (2 x 2 color slides).

Transparencies - Teacher-made transparencies showing sections of various types of control joints.

EQUIPMENT:

16 mm projector, slide projector, overhead projector, screen.

Tools - jointer or groover, power joint cutter.

PRIMARY REFERENCES:

1) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

2) Design and Control of Concrete Mixtures, Chicago: Portland Cement Association, 33 West Grand Avenue, 1952.

3) Suggested Design of Joints and Connections in Precast Structural Concrete, Detroit: American Concrete Institute, 1964.

I. INTRODUCTION AND MOTIVATION

A. Have bimetallic bars set and ready to subject to heat. Heat bimetallic bars and have students observe changes. Heat other materials and have students generate concepts about what changes occur when material is heated. Use these concepts to lead into discussion relative to the need for expansion and contraction control joints.

B. Show film: Better Dummy Joints.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Construction joints. | 1. Necessity for construction joints.<br>a. Total structures frequently cannot be made in one pour<br>b. Frequently serve as control joints<br><br>2. Use of rustication strips for horizontal joints.<br>a. Method of locating in form<br>b. Pouring procedures<br><br>3. Vertical joints<br>a. Groove and tenon<br>b. Vee shaped<br>c. Sealing<br>1) Hot pitch<br>2) Sealing strip of sheet metal | 1. Sight lines and joint placement for appearance.<br><br>2. Principles relating to elasticity of materials. |
| B. Joining new concrete with old. | 1. Principles involved.<br>a. Roughened surface<br>b. Clean surface<br>c. Damp or wet surface<br><br>2. Procedure.<br>a. Wet surface<br>b. Paint with cement grout<br>c. Paint just ahead of pouring area<br>1) Grout must be wet and fresh when concrete bonds with it | 1. Effect of dust or dry material at joining surfaces.<br><br>2. Develop an understanding of:<br>a. Adhesion<br>b. Cohesion<br>c. Fusion |
| C. Expansion and contraction joints. | 1. Principles involved.<br>a. Thermal expansion<br>b. Thermal contraction<br>c. Contraction by drying<br>d. Expansion by wetting<br>e. Necessity for providing for integrity and appearance of the structure<br><br>2. Materials used.<br>a. Metal strips<br>1) Copper<br>2) Galvanized iron<br>b. Bitumen treated felt<br>c. Plastics<br><br>3. Methods<br>a. Keyway joints<br>b. Sliding joints<br>c. Open joints with elastic filler and cover plates | 1. Coefficients of thermal expansion.<br><br>2. Expansion from absorption of moisture.<br><br>3. Effect of concrete materials on:<br>a. Copper<br>b. Galvanized iron<br><br>4. Principles of galvanic action. |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| 1. Develop concept of multiple spacing.<br>a. Balance<br>b. Rhythm<br>c. Proportion | 1. Vocabulary building.<br>a. Rustication<br>b. Vertical joints<br>c. Control joints<br>d. Expansion<br>e. Contraction<br>f. Dummy joints | 1. Potential problems related to concrete construction in Alaska and other cold areas.<br>a. Control problems<br>b. Construction problems<br>c. Ecological problems |
| | 1. Develop ability to:<br>a. Think<br>b. Evaluate<br>c. Hypothesize<br>d. Synthesize | |
| 1. Computation of the amount of expansion or contraction due to:<br>a. Thermal changes<br>b. Moisture changes | 1. Read about materials used for expansion joints.<br>a. Develop ability to make critical evaluations of materials | 1. Effect of faulty expansion joints on highway construction.<br>a. Hazards developed<br>b. Tax misuse |
| | | |

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| D. Dummy joints. | 1. Necessity of crack control.<br>2. Methods.<br>a. Depth of cut<br>b. Width of cut<br>c. Use of groover<br>3. Placement of joints<br>a. Functional applications<br>b. Visual applications | |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| 1. Reinforcement of fractions as related to:<br>a. 1/3 thickness of concrete<br>b. Five equal spaces for a given length | | |

III. APPLICATION

A. Discuss various types of control joints and joint filler materials.

B. Demonstrate methods of joining freshly poured concrete to a new batch of concrete.

C. Demonstrate how to join fresh concrete to hardened concrete--the use of cement grout.

D. Demonstrate how to make expansion control joints and crack control joints.

IV. EVALUATION CRITERIA GUIDELINE

A. What are crack control joints?

B. Explain how to prepare the surface of hardened concrete to correctly accept fresh concrete.

C. What is a rustication? Why is it used?

D. Does concrete expand and contract with changes in temperature? Changes in moisture?

V. SUMMARY

A. Concrete like other materials expands with heat and contracts when cooled. Hence, it becomes necessary to provide joints which permit movement without damaging the structure or the concrete material. Also when fresh concrete is added to previously poured hardened concrete certain steps must be taken to insure a correct bond between the two batches. Crack control joints are used to insure that inevitable cracks will occur at points where they will not injure the structure.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Introduction and motivation

60 minutes -- Integrated curriculum concepts

90 minutes -- Presentation of principles

150 minutes -- Practical application

30 minutes -- Summary and evaluation

## VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Control Joints Regulate Effects of Volume Change in Concrete Masonry, Detroit: American Concrete Institute Journal, July 1957.

2) Dalzell, Ralph and Townsend, Gilbert, Masonry Simplified, Vols. I and II, Chicago: American Technical Society, 1960.

3) Graham, Frank D., Mason's and Builder's Guide, Vol. 3, Indianapolis: Theodore Audel, 1962.

INSTRUCTOR'S UNIT PLAN

Unit 15
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Handling and Placing Concrete

AIM:

To teach the correct methods for transporting and placing concrete.

INSTRUCTIONAL AIDS:

Film - How to Transport, Place, Finish, and Cure Quality Concrete, Harrisburg: Modern Talking Picture Service, Inc., J. P. Lilley & Sons, 2009 N. 3rd Street (32 minutes, 16 mm, sound, color).

Slides - Mr. Quality Concrete, Slides #12 to #15 Inclusive, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (2 x 2 color slides).

EQUIPMENT:

16 mm projector, 35 mm slide projector, screen.

Wheelbarrows, two-wheel concrete cart.

PRIMARY REFERENCES:

1) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

2) Huff, Darrell, How to Work with Concrete and Masonry, New York: Harper & Row Publishers, Inc., 1970.

3) Recommended Practices for Measuring, Mixing, and Placing Concrete, Bulletin 614-59, Detroit: American Concrete Institute, 1959.

I. INTRODUCTION AND MOTIVATION

A. Have some rather wet concrete prepared and drop it approximately five feet into a box with plexiglass front. Show the amount of material segregation which takes place. Discuss need for placing concrete rather than pouring it. The work and work site must be properly prepared so that concrete may be placed efficiently--stress need for planning.

B. Show film: How to Transport, Place, Finish, and Cure Quality Concrete.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Preparation for receiving concrete on the site. | 1. Preparation of subgrade must be completed.<br><br>2. Form properly erected.<br>a. Proper grade, shape, and dimensions<br>b. Reinforcement must be placed<br>c. Provisions made for wheeling or chuting concrete to formed area<br><br>3. Site must be cleared to enable truck maneuvering. | |
| B. Movement or transportation at job site. | 1. Delays in unloading concrete must be avoided.<br>a. Time-cost factor<br>b. Stiffening of concrete<br>c. Maximum unloading time allowed<br><br>2. Truck should get as close to unloading site as possible.<br><br>3. On-site transportation.<br>a. Wheelbarrows<br>b. Two-wheel buggies<br>c. Crane buckets<br>d. Pneumatic pumps<br>e. Drop chutes | 1. Various classes of levers as they relate to:<br>a. Wheelbarrows<br>b. Two-wheel buggies<br>c. Crane bucket releases<br><br>2. Principles of movement of materials by pneumatics. |
| C. Placing concrete in forms. | 1. Forms must be properly constructed.<br>a. Proper bracing<br>b. Oiled<br>c. Clean of debris<br>d. Reinforcement securely fastened and rust free<br><br>2. Concrete placed as close to final position as possible.<br>a. Prevent pushing, dragging or pouring of concrete<br>b. Use of chutes<br>a. Straight chutes<br>b. Drop chutes<br><br>3. Consolidating or compacting concrete.<br>a. Hand spading<br>b. Vibrators<br>1) Inserted 12" to 18" spacing<br>2) Vibrate 5 to 15 seconds<br>c. Dry mix vibration is good; wet mixes tend to bring excess moisture to the surface<br>d. Overvibration or vibration against reinforcing can force a form apart | 1. Effects of long drops, excessive movement of concrete, and excessive vibration of concrete on the quality of the job.<br>a. Segregation<br>b. Principles of alluviation<br><br>2. The effect of vibration against reinforcing steel. |

TO BE DEVELOPED

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| 1. Measuring truck clearance.<br>a. Height<br>b. Width<br>c. Turning radius | | 1. Effects of temperature on concrete in terms of ordinances and regulations controlling cold weather concrete placement. |
| 1. Ratios as they relate to air cylinders and pressures generated.<br><br>2. Computation of time-materials costs. | 1. Use of hand signals and other means of communication when noise or distance prevent normal verbal communications. | |
| | | |
| 1. Computation of angles of repose.<br>a. Chute placement and rate of fall of concrete as a factor of the angle of the chute<br>b. Amount of "roll" of fresh concrete--angle of repose | 1. Keeping records of quantities of concrete placed.<br>a. Signing material receipt slips<br>b. Checking quantities<br>c. Recording techniques | 1. Regulations concerning occupancy or removal of concrete forming and support structures. |

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| D. General considerations. | 1. Adding water at job site.<br>a. Should be avoided<br>1) Weakens concrete<br>2) Affects watertightness<br>3) Affects durability<br>b. Adding water to thin concrete to make it more plastic should never be permitted<br><br>2. Placing concrete requires work and the use of water to thin concrete may reduce the work but it will result in an inferior product. | |
| E. Safety. | 1. Transporting concrete.<br>a. Be sure the load is not too great<br>b. Be sure of your footing<br>c. Be sure scaffolding, planks and ramps are strong and secure<br><br>2. Stay clear of form supports.<br>a. Do not bump form supports which may cause freshly poured or uncured concrete to collapse<br>b. After initial placing check forms for rigidity and strength | 1. Chain reaction when a brace, support or other structural member fails and places excessive stress on other members. |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| | 1. Reading and understanding terminology and content of insurance policies. | 1. Investigation of various types of insurance.<br>a. Life<br>b. Hospitalization<br>c. Income<br>d. Retirement |
| | 1. Reading safety regulations.<br>2. Filling out insurance forms.<br>3. Writing letters relative to accidents or accident claims.<br>4. Completing accident reports. | 1. Workmen's compensation laws.<br>a. Death resulting from accidents<br>b. Back injuries and other similar injuries<br>c. Benefits |

III. APPLICATION

A. Discuss handling and placing of concrete.

B. Discuss the job site and planning necessary for delivery of concrete.

C. Have students wheel wet stone and sand mixes in a wheelbarrow and two-wheel cart or Georgia buggy.

D. Reinforce learning of forms being ready to receive concrete. Discuss wheeling ramps to form areas.

E. Have students place concrete in a narrow form.

IV. EVALUATION CRITERIA GUIDELINE

A. Describe planning necessary before concrete is delivered to the site.

B. What is honeycombing in relationship to concrete?

C. What means are used to transport concrete from the mixer or truck to placement location?

D. Explain how to place concrete in a deep, narrow form.

E. Why must uniform placing and consolidation methods be used?

V. SUMMARY

A. Correct methods must be used to place concrete if a quality job is to result. Improper methods can result in honeycombing, sand streaking, and segregation of the concrete material. Care must be taken to assure that concrete is placed and not poured, is not dropped from too great a height, nor overvibrated. Also, concrete must be placed within 30 to 60 minutes after mixing.

VI. SUGGESTED TIME AND SEQUENCE LISTING

45 minutes -- Introduction and motivation

60 minutes -- Integrated curriculum concepts

90 minutes -- Presentation of principles relating to concrete placement

135 minutes -- Practical application--practice with concrete moving equipment and placement of concrete in various situations

30 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Dalzell, Ralph and Townsend, Gilbert, Masonry Simplified, Vols. I and II, Chicago: American Technical Society, 1960.

2) Graham, Frank D., Mason's and Builder's Guide, Vol. 3, Indianapolis: Theodore Audel, 1962.

3) Guide for Construction of Concrete Floors on Grade, Detroit: American Concrete Institute, 1962.

INSTRUCTOR'S UNIT PLAN

Unit 16
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Concrete Finishing

AIM:

To teach the operations which must be performed to obtain an attractive, durable finish to the concrete surface.

INSTRUCTIONAL AIDS:

Film - How to Transport, Place, Finish, and Cure Quality Concrete, Harrisburg: Modern Talking Picture Service, Inc., J. P. Lilley & Sons, 2009 N. 3rd Street (32 minutes, 16 mm, sound, color).

Film - Concrete Example, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (16 minutes, 16 mm, sound, color).

Slides - Mr. Quality Concrete, Slides #16 to #20 Inclusive, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (2 x 2 color slides).

Samples - Teacher-made 2" x 12" x 12" concrete sample slabs showing various types of concrete finishes.

EQUIPMENT:

16 mm projector, slide projector, screen.

Finishing trowels, finishing floats, darbies, edgers, corner tools, groovers, jitterbug floats, bull floats, rub bricks and power trowels.

PRIMARY REFERENCES:

1) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

2) Giese, Henry, A Practical Course in Concrete, Chicago: Portland Cement Association, 1948.

3) Goldblatt Trowel Trades Tool Catalog, Kansas City: Goldblatt Tool Company, 511 Osage Street, Kansas City, Kansas, Latest Edition.

4) Huff, Darrell, How to Work with Concrete and Masonry, New York: Harper & Row Publishers, Inc., 1970.

## I. INTRODUCTION AND MOTIVATION

A. Have on display example slabs of concrete finishes. Generate discussion relative to the function of the various finishes and methods used to obtain them.

B. Display concrete finishing tools--elicit suggestions for use of these tools.

C. Proceed into lesson and develop an understanding and skill in the use of basic tools.

D. Show applicable part of film: How to Transport, Place, Finish and Cure Quality Concrete.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Consolidating concrete. | 1. Function of the process.<br>a. Providing uniform plastic mass<br>b. Eliminating stone pockets<br>c. Eliminating large air voids<br><br>2. Methods used.<br>a. Tampers<br>b. Rollers and roller screeds<br>c. Jitterbugs, jitterbug crawler<br>d. Strike-off board or straightedge<br>1) Strike-off usually used | 1. Theories and principles of mixing and compaction to produce a uniform mass.<br><br>2. Pressures developed via tamping.<br>a. Area vs. downward force |
| B. Leveling concrete. | 1. Function.<br>a. To level concrete to screed or grade stakes<br>b. Remove ridges and irregularities<br>c. Produce a true, even surface<br><br>2. Frequently a combined effort.<br>a. Leveling and consolidation by use of strike-off board<br><br>3. Method.<br>a. Aluminum or magnesium straightedge<br>b. 2 x 4 or 2 x 6 straightedge<br>c. Reciprocating motion with one end slightly advanced of the other<br>d. Keep some concrete ahead of the strike-off board to fill low spots and assist in consolidation | 1. The strike-off process--how and why it works a mortar to the surface. |
| C. Producing a working surface--darbying and bull floating. | 1. Function.<br>a. Helps smooth surface by eliminating ridges and voids<br>b. Helps to lower or embed large aggregate<br>c. Aids in producing mortar surface for further finishing<br><br>2. Methods used.<br>a. Bull floating<br>b. Darbying<br><br>3. Some precautions.<br>a. Should be done before water bleeds to the surface<br>b. Do not overwork the concrete | |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| | 1. Explore the need for various types of concrete finishes.<br>a. Emphasize logic and rationale development | |
| 1. Computing amount of fall for drainage purposes.<br>a. Total length drainage<br>b. Fall per foot | 1. Vocabulary development of terms related to concrete finishing. | 1. The effects of highways on economy and development of:<br>a. Rural areas<br>b. Urban areas |
| 1. Computing and recording labor time figures for cost and estimating purposes. | | |
| | | |

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| D. Jointing. | 1. Function.<br>a. To control cracks and contraction cracks by cutting a weakened plane into the concrete<br>2. Method.<br>a. Joint cut to 1/4 the depth of concrete with:<br>1) Edge of trowel and straightedge<br>2) Groover with a bit<br>3) Masonry saw<br>b. Spacing<br>1) 4 to 5 ft. on sidewalks<br>2) 10 to 15 ft. on driveways<br>3) Consider uniform spacing within limits for appearance<br>3. Some precautions.<br>a. Done when water bleed and sheen have left the surface<br>b. If cut with masonry saw, do 4 to 12 hours after placing and finishing | 1. Expansion and contraction.<br>a. Tension cracks<br>b. Forcing cracks to form at weakened areas<br>c. Uplifting or cracking caused by expansion |
| E. Edging. | 1. Function.<br>a. Appearance<br>b. Produce stronger edge<br>1) Prevents chipping<br>2) Prevents spalling<br>2. Method.<br>a. Hand edgers<br>1) Small radius<br>2) Large radius<br>3) Step and corner<br>4) Curb and gutter<br>5) Base tool<br>b. Long handled edgers<br>1) Rotating head<br>2) Flip-flop<br>3. Some precautions.<br>a. Be sure all large aggregate is covered with mortar<br>b. Be sure edge is straight<br>c. Small radii are easier to maintain than large when used at joints | 1. The use of radii or rounds and fillets to distribute stress.<br>a. Compare with metal castings |
| F. Floating. | 1. Function.<br>a. Remove small humps<br>b. Fill small depressions<br>c. Compact concrete<br>d. Develop a working surface | |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| 1. Math as it relates to figuring expansion and contraction.<br><br>2. Converting from Fahrenheit to centigrade and the reverse.<br><br>3. Uniform divisions within allowable limits when designing a walk or driveway. | 1. Development of pertinent talks or demonstrations to other trainees or workers. | 1. Competition and free enterprise.<br>a. Research and development of products<br>b. Research on uses of concrete<br>c. Development of finishes, etc. |
| 1. Review or present concept of radii and curve generation.<br><br>2. Review concept of tangent points as relates to fillets and corners. | | |
| | 1. Reading and understanding specifications relating to finishing concrete. | 1. Lawsuits and fixing of responsibility when a concrete product fails.<br>a. Compliance to specifications<br>b. Faulty workmanship<br>c. "Act of God" |

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| | 2. Method.<br>a. Hand<br>1) Wood floats<br>2) Cork floats<br>3) Metal floats<br>b. Machine<br>1) 3 and 4 blade<br>2) Adjustable pitch<br>3) Float and trowel pads<br><br>3. Timing.<br>a. When all water sheen has left concrete<br>b. When experience directs | |
| G. Final finishing. | 1. Function.<br>a. To produce the desired surface finish<br>1) Smooth--steel trowel<br>2) Hand float<br>3) Broom<br>4) Burlap or belt<br>5) Novelty<br><br>2. Methods.<br>a. Hand steel troweling<br>b. Machine steel troweling<br>c. Hand floating<br>1) Not initial floating<br>2) Gritty non-skid finish<br>3) Can be swirl pattern<br>d. Broom<br>1) Usually straight line bristle lines<br>2) Can produce checker-board or other patterns<br>3) Non-skid surface<br>e. Burlap or belt<br>1) Unique finish<br>2) 6" to 12" burlap, rubber, or canvas tool<br>f. Novelty or textured<br>1) Divider strips<br>2) Grooving<br>3) Exposed aggregate | |
| H. Finishing air-entrained concrete. | 1. Few changes from normal concrete.<br>a. Major change is that less water is used; hence, finishing times can start earlier<br>b. Magnesium or aluminum floats and trowels are used for hand methods<br>c. Machine methods are practically same as non-air-entrained concrete except for starting sooner | 1. Reasons why air-entrained concrete would "stick" to a wood float. |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| | | |
| 1. Cost analysis of hand finishing vs. machine. | 1. Oral explanations of the visual and functional effects gained by various surface finishes. | 1. Sidewalk and highway snow removal regulations.<br>2. Taxes and highway maintenance.<br>3. Highway studies in terms of finish on road surface.<br>a. Durability<br>b. Braking safety<br>c. Hydroplaning |
| 1. Cost analysis in terms of comparing finishing time of nonair-entrained concrete with air-entrained concrete. | | |

III. APPLICATION

A. Use catalog to present various tools used in concrete finishing--teach name, use and nomenclature.

B. Have students pour small slabs or pour and finish a slab for some specific job.

C. Have students apply finish to lawn benches, etc.

D. Teach proper tool cleanup and maintenance.

IV. EVALUATION CRITERIA GUIDELINE

A. Why is concrete finished? What is meant by finishing concrete?

B. What is the function of floating?

C. Explain how to make a control joint.

D. How is a steel trowel used for the first floating?

E. Explain what is meant by striking-off.

F. Explain how to clean concrete working tools.

V. SUMMARY

A. The final finish on a concrete slab or other concrete surface largely depends on the function of the piece and the desired visual appearance. Regardless of the finish selected, it must be properly done to assure proper wearing and appearance qualities. Knowing the correct procedures and developing the required skill is important for one desiring to become a concrete worker.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Introduction and motivation

90 minutes -- Integrated curriculum concepts

60 minutes -- Presentation of principles

150 minutes -- Practical application--applying different finishes

30 minutes -- Summary and evaluation

## VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Exposed Aggregate Finishes for Flat Slabs, Chicago: Portland Cement Association, 33 West Grand Avenue, 1962.

2) Finishing Quality Concrete, Chicago: Portland Cement Association, 33 West Grand Avenue, 1964.

3) Witt, J. C., Portland Cement Technology, New York: Chemical Publishing Company, 1966, 2nd Edition.

INSTRUCTOR'S UNIT PLAN

Unit 17
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Concrete Protection and Curing Techniques

AIM:

To teach methods of protecting concrete from adverse weather conditions and also how to cure concrete to achieve a quality product.

INSTRUCTIONAL AIDS:

Film - How to Transport, Place, Finish and Cure Quality Concrete, Harrisburg: Modern Talking Picture Service, Inc., J. P. Lilley & Sons, 2009 N. 3rd Street (32 minutes, 16 mm, sound, color).

Slides - Mr. Quality Concrete, Slides #21 to #24 Inclusive, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (2 x 2 color slides).

Slides - Teacher-made slides showing types of materials used for protection, correct placing of materials and removal of materials.

Samples - Frozen uncured concrete, frozen and hardened concrete, and properly cured concrete.

EQUIPMENT:

16 mm projector, 35 mm slide projector, screen.

PRIMARY REFERENCES:

1) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

2) Design and Control of Concrete Mixtures, Chicago: Portland Cement Association, 33 West Grand Avenue, 1952.

3) Manual of Concrete Practice, Vol. I, Detroit: American Concrete Institute, 1968.

I. INTRODUCTION AND MOTIVATION

A. Have on display three test pieces of concrete--one frozen during curing to show ice crystals, one which was frozen and then thawed and hardened, and one properly cured. Have students attempt to break the various pieces and use the results to lead into the lesson.

B. Show appropriate part of the film: How to Transport, Place, Finish and Cure Quality Concrete.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Reasons for curing concrete. | 1. Function.<br>a. To enable correct and complete hydration<br>b. Increase strength<br>1) If kept moist during first 7 days strength may be increased approximately 50%<br>c. Preventing plastic shrinkage cracks | 1. Time periods for attaining maximum strength of concrete. |
| B. Preventing excessive or rapid evaporation of water. | 1. Planning.<br>a. Placing concrete in the spring and fall seasons if possible.<br>b. Building windbreaks<br>c. Using cool materials<br>1) Aggregates<br>2) Water<br>d. Wetting forms, subgrade, etc. before placing concrete<br>e. Planning for efficient, rapid working of concrete<br><br>2. Keeping concrete moist.<br>a. After concrete has been finished and has attained its initial set<br>b. Spraying with water<br>c. Flooding with water<br>1) Be sure concrete is set enough to prevent erosion<br>d. Ponding--building dikes around edge and filling with water<br>1) Be sure concrete is adequately hardened<br>e. Moisture retained by wet straw, sand or burlap<br>f. Covering wet concrete with plastic films or waterproof paper<br>g. Use of chemical admixtures | 1. Understanding of relative humidity.<br><br>2. Cooling via evaporation.<br><br>3. Rate of evaporation with various wind forces. |
| C. Time required and general conditions for curing concrete. | 1. Time--a minimum of 3 to 7 days.<br><br>2. Temperature range:<br>a. 3 day curing 70°F.<br>b. 5 day curing 50°F.<br>c. Best range--55° to 73°F.<br><br>3. Wind velocity--evaporation rate.<br>a. Increases 4 times from wind speed of 0 to 10 mph<br>b. Increases 9 times from 10 mph to 25 mph<br><br>4. Hydration stops at 33°F.--must maintain temperature above freezing.<br><br>5. No curing is better than alternate wetting and drying. | 1. Experiments with conditions enabling or preventing hydration.<br><br>2. Experiments with wind velocity and humidity relating to rate of evaporation. |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| | 1. Developing appropriate vocabulary. | |
| 1. Computing areas to enable estimation of quantities of protective materials.<br><br>2. Computing the amount of chemical retarders which can safely be added to concrete. | 1. Writing reports of weather conditions for permanent job records.<br><br>2. Writing work schedules and planning procedures. | 1. Economic impact of all weather construction and concrete working. |
| | | 1. Need for controls and legislation to protect the client and public when construction proceeds under adverse conditions. |

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| D. Hot weather concreting. | 1. Basic considerations.<br>a. Cement must harden by hydration<br>b. Approximately 3 gallons of water per bag of cement is necessary for hydration<br>c. Main problem of hot weather concreting is to keep evaporation below the equivalent of 3 gals. per bag of cement<br><br>2. Planning--plan so that no delays occur in placing and finishing the concrete.<br><br>3. Use cool materials.<br>a. Keep aggregates in shade<br>b. Chill the water<br><br>4. Begin curing process immediately after the completion of the finishing process. | 1. Making test specimens in hot weather.<br>a. Conforming to specifications<br>b. Keeping test cylinders cool and damp<br><br>2. ASTM designation C-31. |
| E. Cold weather concreting. | 1. Basic considerations.<br>a. Temperature must be above 33°F. for hydration reaction to take place<br>b. If freezing occurs, hydration will stop--when favorable temperatures occur, hydration will continue<br>c. Repeated freeze-thaw situations will result in lower strength and lower weathering qualities<br>d. Best procedure is to maintain temperatures above freezing until concrete cures<br><br>2. Planning--plan so that no delays in placing or finishing concrete occur.<br>a. Have all forms and equipment ready to receive concrete<br>b. Build protective enclosures<br>c. Have space heaters available<br>d. Have insulating materials available<br>e. Use high-early-strength concrete<br><br>3. Use warm materials.<br>a. Heat fine aggregate<br>b. Under severe conditions heat coarse aggregate<br>c. Heat mixing water | 1. The effect of excessively heated materials on concrete.<br>a. Flash set<br><br>2. Temperature mixture ratios--heat transfer from various materials.<br>a. Stone to water<br>b. Reinforcing steel to concrete<br><br>3. Chemical reaction of calcium chloride as an accelerator for hardening concrete. |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| 1. Computations relating to ASTM C-31 concrete tests. | 1. Keeping records of test specimen collection.<br>a. Conditions of collection<br>b. Recording protective conditions for samples<br><br>2. Reporting results of tests. | |
| 1. Estimating additional costs due to material, equipment and labor needed to protect concrete against freezing.<br><br>2. Estimating excavation costs in cold weather. | 1. Writing reports of weather conditions for permanent job records.<br><br>2. Writing requisitions for:<br>a. Protective materials<br>b. Purchase of space heaters<br>c. Rental of space heaters | 1. Study of working conditions for cold weather concrete work. Consider:<br>a. Discomfort<br>b. Safety<br>c. Compensation<br>d. Time lost due to bad weather<br><br>2. Causes for highway deterioration during freeze-thaw periods. |

RELATED CONCEPTS

| INSTRUCTIONAL TOPICS | TECHNICAL CONCEPTS | SCIENCE |
|---|---|---|
| | d. Keep material temperatures so that mixed concrete is between 50-70°F. when placed<br>1) Do not heat water above 140°F.<br>2) Guard against flash set<br><br>4. Use chemical accelerators.<br>a. Use sparingly<br>b. Follow directions<br><br>5. Protect fresh concrete.<br>a. Cover with insulating materials<br>b. Use space heaters to prevent freezing<br><br>6. Begin curing immediately. | |

TO BE DEVELOPED

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
| --- | --- | --- |
| | | |

III. APPLICATION

A. Introduce lesson with experiment regarding strength of properly cured concrete and improperly cured concrete.

B. Demonstrate the results of hot, windy atmosphere on concrete via a setup with heat lamp and fan.

C. Demonstrate measures used to retain moisture in concrete.

D. Using a lab setup, demonstrate cold weather effects on concrete.

E. Demonstrate methods of maintaining minimum curing temperature.

F. Demonstrate normal high strength curing techniques.

IV. EVALUATION CRITERIA GUIDELINE

A. What precautions must be taken when using chemical accelerators?

B. List procedures and conditions most conducive to properly curing concrete.

C. List methods of retaining moisture in concrete during hot, windy and low humidity weather.

D. What temperature range is best for curing concrete?

E. Why does hydration stop when the temperature drops below freezing?

F. What are plastic shrinkage cracks in concrete?

V. SUMMARY

A. Concrete working must go on throughout the year and at various seasons adverse weather conditions exist; therefore, protective measures must be taken to assure a quality job. The best seasons of the year are spring and fall in regard to concrete curing. Even under these good conditions the concrete worker must exercise care to see that concrete remains moist during the curing period. Proper control of all conditions will result in quality concrete and the concrete worker must know how to control the various conditions.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Introduction and motivation

90 minutes -- Experiments simulating various adverse weather conditions

60 minutes -- Demonstration and discussion of various aspects of concrete curing

60 minutes -- Integrated curriculum concepts

90 minutes -- Practical application

30 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Cold Weather Concreting, U. S. A. Standards, Detroit: American Concrete Institute, 1966.

2) Curing Concrete, Detroit: American Concrete Institute, 1958.

3) Recommended Practice for Hot Weather Concreting, Detroit: American Concrete Institute, 1958.

INSTRUCTOR'S UNIT PLAN

Unit 18
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Stripping Forms from Concrete

AIM:

To teach when to remove concrete forms, techniques used and the surface effects caused by properly prepared and improperly prepared forms.

INSTRUCTIONAL AIDS:

Slides - Teacher-made slides of the sequential steps involved in form removal. Include on-the-job constructed forms and commercial forms.

EQUIPMENT:

35 mm slide projector, screen, and tools needed for form removal.

PRIMARY REFERENCES:

1) Formwork for Concrete, Detroit: American Concrete Institute, 1969.

2) Huff, Darrell, How to Work with Concrete and Masonry, New York: Harper & Row Publishers, Inc., 1970.

I. INTRODUCTION AND MOTIVATION

A. Explain that while the concrete contained within a formed area is hardened and perhaps even cured to a point of near maximum strength, it is still "green" and subject to damage from sharp, prying tools.

B. Elicit discussion relative to how improper form removal might damange concrete.

RELATED CONCEPTS

| INSTRUCTIONAL TOPICS | TECHNICAL CONCEPTS | SCIENCE |
|---|---|---|
| A. Timing for stripping forms. | 1. General rule--forms should remain in place until the concrete has hardened sufficiently and acquired the strength required to support its own weight and any other loads which may initially be placed on it.<br><br>2. Under good conditions column forms may be stripped in 48 to 72 hours.<br><br>3. Plinth forms may be stripped in 72 to 96 hours.<br><br>4. Under most circumstances forms may be stripped in 72 hours.<br><br>5. Smaller nonweight supporting forms such as steps on grade may be stripped in 48 hours or less. | |
| B. Stripping on-the-job constructed wood forms. | 1. General principle--pry form material free without levering against the concrete.<br>a. Common nails--pry out board--drive back and pull nails<br>b. Double head nails or scaffold nails--pull nails with claw hammer or crowbar<br><br>2. Remove boards, stakes, etc. and draw nails immediately.<br><br>3. Where overhangs, recessed panels, or other decorative impression strips are used, the form must be carefully removed so that concrete flash and form resistance do not damage formed concrete.<br>a. Adhesion of form to concrete<br>b. Vacuum formed from air free contact of form and concrete<br><br>4. Wall forms and other forms using bolts, ties, rangers, and studs should be removed in a planned sequence.<br>a. Remove bolts<br>b. Remove rangers<br>c. Remove or cut ties<br>d. Remove form panel<br>e. If required, disassemble form panel | 1. Principles involved in oiling or applying other form release agents.<br><br>2. Use of levers for prying, pulling nails, etc.<br><br>3. Testing holding power of nails.<br><br>4. Principles relating to air pressure and vacuum. |
| C. Commercial forms. | 1. Wall forms.<br>a. Removal of clamps, keys or bolts depending on the type of form | 1. Mechanical advantage of pulleys and hoisting mechanisms. |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| | 1. Keeping records of dates and time of placing concrete. Correlating this information with weather conditions to check form removal time. | 1. Safety regulations for the building industry. |
| 1. Estimating the amount of form oil required for oiling a certain area of forms. | | |
| | 1. Writing for information about commercial forms. | 1. Information systems for industrial ordering and transmittal of information. |

RELATED CONCEPTS

| INSTRUCTIONAL TOPICS | TECHNICAL CONCEPTS | SCIENCE |
|---|---|---|
| | b. Lifting the metal form panel from the area<br>1) Safety<br>2) Lifting by manpower<br>3) Hoisting by crane<br>c. Twisting off patented wall ties or wire<br><br>2. Floor forms.<br>a. Flat floor panels<br>b. Beam and pan panels<br>1) Planned removal sequence<br>2) Careful and safe removal of support posts<br>3) Lowering of flat or pan panels<br>4) Stress safety | |
| D. Cleaning forms. | 1. Properly oiled or treated forms are easy to clean.<br>a. Scraping<br>b. Wire brushing<br><br>2. Form material should be cleaned immediately after removal.<br>a. Discard or salvage good material from split or damaged wood<br>b. Remove all nails<br>c. Remove dents, repair or weld damaged areas on metal forms<br>d. Clean threads on bolts, etc. Rethread if necessary<br><br>3. Oil metal forms to prevent rust formation. | 1. Composition of chemical concrete releasing agents. |

TO BE DEVELOPED

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| | 2. Reading about form systems in Sweet's Architectural File.<br><br>3. Information retrieval systems for libraries and commercial organizations. | |
| 1. Computation of form cleaning time.<br><br>2. Computing salvage costs vs. time for cleaning. | | 1. Impact of solid waste disposal on the ecology.<br><br>2. Concept of planned obsolescence and form materials. |

III. APPLICATION

A. Introduction and presentation of the need for correct procedures and care in removing forms.

B. Demonstrate how to remove forms to prevent chipping of overhangs, panels, or other edges developed by the form.

C. Have students form benches, flower containers, birdbaths and other similar items with panel areas, decorative textures or other indentations and when concrete is properly cured, remove forms.

D. If possible, have students remove commercial forms.

IV. EVALUATION CRITERIA GUIDELINE

A. How are tie wires treated when forms are removed?

B. What is the average curing period before forms may be removed?

C. Explain how to remove on-the-job constructed step forms.

D. What surface effect may result from improperly oiled forms?

E. What proportions are used for surface facing plaster to fill small voids and provide uniform texture when forms are removed?

V. SUMMARY

A. Removal of concrete forms must be done when the concrete has properly cured to the point where it will support its own weight and other existing weight. Forms must be carefully removed to protect the concrete and enable reuse of the form material. On large jobs, nuts, bolts, wedges, rangers and other form material must be separated for efficient reuse. Proper form removal will aid in producing a quality concrete product and the concrete worker should know how to properly remove forms.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Introduction and motivation

60 minutes -- Integrated curriculum concepts

60 minutes -- Demonstration of form removal

180 minutes -- Practical application

30 minutes -- Summary and evaluation

VI. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Concrete Formwork, Albany, New York: Delmar Publishers, Inc., 1962.

2) Dalzell, Ralph and Townsend, Gilbert, Masonry Simplified, Vols. I and II, Chicago: American Technical Society, 1960.

3) U. S. A. Standard Recommended Practice for Concrete Formwork, Detroit: American Concrete Institute, 1968.

INSTRUCTOR'S UNIT PLAN

Unit 19
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Special Finishes, Textures and Coloring

AIM:

To broaden the student's range of alternatives for designing and using concrete finishes.

INSTRUCTIONAL AIDS:

Film - How to Make Decorative Patio Floors for Outdoor Living, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (19-1/2 minutes, 16 mm, sound, color).

Film - Concrete Curtain Walls, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (18 minutes, 16 mm, sound, color).

Film - A Sense of Perception, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (16 minutes, 16 mm, sound, color).

Slides - Teacher-made slides of various concrete textures and colored concrete.

EQUIPMENT:

16 mm projector, 35 mm slide projector, screen.

A number of concrete panel forms approximately 2" x 2'-0" x 2'-0", material for mixing concrete, various surface aggregates, chipped marble, pebbles, etc. Concrete coloring agents, necessary tools, trowels, brushes, etc.

PRIMARY REFERENCES:

1) Cement Mason's Manual for Residential Construction, Chicago: Portland Cement Association, 33 West Grand Avenue, 1960.

2) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

3) Huff, Darrell, How to Work with Concrete and Masonry, New York: Harper & Row Publishers, Inc., 1970.

I. INTRODUCTION AND MOTIVATION

A. Show film: How to Make Decorative Patio Floors for Outdoor Living and generate discussion relative to texture and color effects possible with concrete. Show various texture materials and coloring agents and elicit comments regarding how they might be used. Proceed with lesson.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. Trowel or surface of floated concrete finishes. | 1. Broom finish.<br>a. Done after final floating<br>b. Stiff bristled broom<br>c. Straight line or wavy pattern<br>d. Nonslippery surface<br><br>2. Swirl pattern.<br>a. Aluminum float<br>b. Cork float<br>c. Steel trowel<br><br>3. Circle or other geometric design.<br>a. Darby--good grout surface<br>b. Press can rims or other circular shaped cylinders into surface to leave impression<br>1) Formal pattern<br>2) Random pattern<br>3) Overlapping pattern | 1. Braking or nonskid aspects of various roughened surface concretes.<br>a. Stopping distances on highways with various surface treatments |
| B. Exposed aggregate finishes. | 1. Concrete mix.<br>a. 5-1/2 to 6 bag concrete<br>b. Maximum 3" slump<br><br>2. Place concrete.<br>a. Screed<br>b. Darby<br><br>3. Add aggregate (surface).<br>a. Gravel or pebbles<br>b. Granite chips<br>c. Size<br>1) 1/2 to 3/4"<br>2) Avoid flat aggregates<br>d. Pat or darby into or embed in surface<br><br>4. Removing grout.<br>a. Permit to set to correct degree<br>b. Brush and hose grout and sand to expose aggregate<br>c. Do not overexpose aggregate<br>1) Slightly less than 1/2 nominal size of aggregate | |
| C. Tooled or scored designs. | 1. Random geometric designs--grooved, tooled or scored into surface.<br>a. Jointer or groover<br>b. 1/2" dia. bent pipe<br><br>2. Bush hammer finish.<br>a. Done by experienced finishers<br>b. Concrete uniformly chipped (tooled) with a power hammer | |

*TO BE DEVELOPED*

| MATH | COMMUNICATIONS | SOCIAL STUDIES |
|---|---|---|
| 1. Experimentation and drawing of geometric shapes and design.<br>a. Construction techniques<br>b. Patterns possible | 1. Writing descriptions of various types of surface textures.<br>a. Use of pictures or sketches to amplify writing | 1. Use of studded tires on highways.<br>a. Safety aspects<br>b. Highway wear aspects |
| 1. Computing amount of surface aggregate required for a given area.<br>a. Density considerations<br>b. Aggregate size considerations | | |
| | 1. Writing specifications for precast concrete.<br>a. Size-shape descriptions<br>b. Concrete mix descriptions<br>c. Tooling or polishing specifications | 1. Use of cast stone (concrete) in various structures.<br>2. Concrete sculpture.<br>a. Works of note<br>b. Artists of note |

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| D. Impression finishes. | 1. Leaf design.<br>a. Leaves troweled flush to surface<br>b. Various sizes and types of leaves<br>c. Do not trowel mortar over leaves<br>d. Carefully remove leaves when concrete has set or remove with wire brush and water when concrete is cured<br><br>2. Other organic materials may also be embedded. | 1. Discussion of properties and classification of organic and nonorganic matter. |
| E. Colored surfaces. | 1. Dry-shake method.<br>a. Done after final floating and when free water has left surface<br>b. Color must be spread evenly<br>c. After color has absorbed moisture it must be steel troweled<br>d. Provide additional troweling for dense surface<br><br>2. Mix method.<br>a. Concrete colors are mixed in with the concrete<br>b. Use of white cement provides brighter colors | 1. Types of colors used for concrete work.<br><br>2. Composition and use of concrete waxes.<br><br>3. Composition of surface sealers. |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| | | |
| 1. Quantities of coloring materials used for area or volume situations. | 1. Reading directions on concrete coloring containers.<br>a. Proportion information<br>b. Use direction | 1. Guarantees as related to color permanency and color intensity.<br><br>2. General discussion of guarantees and warranties. |

III. APPLICATION

A. Introduce lesson and show film: How to Make Decorative Patio Floors for Outdoor Living.

B. Have students propose various texture treatments which they feel could be logically and practically attained.

C. Show additional films or teacher-made slides of various unique concrete finishes.

D. Using the 2'-0" x 2'-0" form demonstrate how to color concrete, produce a textured surface, etc.

E. Have students produce 2" x 2'-0" x 2'-0" patio tiles of different types

IV. EVALUATION CRITERIA GUIDELINE

A. What is an exposed aggregate finish?

B. Why are mineral oxides used for coloring concrete?

C. Explain the procedures used for producing an exposed aggregate finish when using random sized pebbles.

D. How is a leaf impression made in concrete?

E. List six surface finishes for concrete.

F. What special precaution must be taken for exposed aggregate concrete?

V. SUMMARY

A. Man's creativity has produced many unusual finishes for concrete which are especially suited for special situations where texture, color and the strength and durability are important. The skilled concrete worker must know how to produce these finishes and should also be aware of the limitations of each finish. Proper finish selection can add both function and aesthetic appeal to a concrete job.

VI. SUGGESTED TIME AND SEQUENCE LISTING

45 minutes -- Introduction and motivation

60 minutes -- Integrated curriculum concepts

60 minutes -- Discussion and demonstration

165 minutes -- Practical application--students making patio blocks

30 minutes -- Summary and evaluation

VII. SUPPLEMENT REFERENCES AND RESOURCE MATERIALS

1) Guide to Portland Cement Plastering, Detroit: American Concrete Institute, 1963.

2) Recommended Practice for the Application of Portland Cement Paint to Concrete Surfaces, Bulletin ACI-616-49, Detroit: American Concrete Institute, 1949.

INSTRUCTOR'S UNIT PLAN

Unit 20
Lesson 1
Time 6 Hours

CLUSTER: CONSTRUCTION

DIVISION: CONCRETE WORK

SUBJECT: Machine Applications and Modern Techniques

AIM:

To familiarize students with modern machine tools and methods of spraying concrete, coating concrete and placing concrete.

INSTRUCTIONAL AIDS:

Film - No Longer a Luxury (Slip Form Takes Hold), Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (14-1/2 minutes, 16 mm, sound, color).

Film - Concrete in the Sixties--Report No. 9, Chicago: Portland Cement Association, Photographic Services Section, 33 West Grand Avenue (22 minutes, 16 mm, sound, color).

EQUIPMENT:

16 mm projector, screen.

Transportation for field trip.

PRIMARY REFERENCES:

1) Concrete Technology--Instructor's Guide, Chicago: Portland Cement Association, 33 West Grand Avenue, 1963.

2) Manual of Concrete Practice, Vols. II and III, Detroit: American Concrete Institute, 1968.

3) Shotcreting, Detroit: American Concrete Institute, 1966.

I. INTRODUCTION AND MOTIVATION

A. Elicit discussion relative to automated or machine methods of working concrete.

B. Show film: No longer a Luxury (Slip Form Takes Hold). Discuss pertinent points and proceed with lesson.

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| A. New uses for concrete. | 1. Soil paving concrete.<br>a. Highly compacted mixture of soil, roadway material, cement and water<br>b. Uses<br>1) Roads<br>2) Streets<br>3) Reservoir linings<br>4) Dam facings<br><br>2. Precast concrete.<br>a. Generally cast off of job site in factories<br>b. Uses<br>1) Building components<br>2) Tilt-up panels<br>3) Building modules<br>4) Piles<br>5) Beams and girders<br>6) Rigid frames<br><br>3. Concrete buildings.<br>a. Shell design concrete<br>b. Plastic concrete permits unusual shapes and forms<br>c. Is fireproof<br>d. Relatively maintenance free<br><br>4. Lightweight concrete.<br>a. Insulating concrete<br>b. Structural lightweight concrete<br>c. Uses<br>1) Insulating walls<br>2) Cast-in-place walls<br>3) Precast walls, roofs<br>4) Concrete block | 1. Principles of cantilever design.<br><br>2. Aggregates used for lightweight concrete. |
| B. Shotcrete plaster and concrete. | 1. Principle.<br>a. Cement and aggregates are pneumatically forced through a nozzle where water is added to produce a plaster or concrete<br><br>2. Properties.<br>a. Very dense concrete<br>b. Very strong<br>c. Weather resistant<br>d. Good water resistance<br>e. Good abrasion resistance<br><br>3. Uses.<br>a. Swimming pools, reservoirs, etc.<br>b. Certain shell forms<br>c. Plastering | 1. Use of pneumatic power to move dry materials.<br><br>2. Testing concrete for abrasion resistance.<br><br>3. Water displacement and floating of concrete boats. |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| 1. Discussion of geometrics of warped surfaces for generating strength.<br>a. Single plane curves<br>1) Long barrel<br>2) Short barrel<br>b. Compound curves<br>1) Hyperbolic paraboloid<br>2) Dome shells<br>c. Pleated surfaces<br>1) Vee shaped<br>2) Modified W<br><br>2. Computations of weight of various aggregates used for lightweight concrete.<br><br>3. Comparisons of weight of normal concrete and lightweight concrete. | 1. Write an essay on a contemporary or new use of concrete.<br><br>2. Building vocabulary relating to technological advances in concrete use.<br>a. Soil paving<br>b. Shotcreting<br>c. Thin shell construction<br>d. Hyperbolic paraboloid<br>e. Tilt-up construction<br>f. Etc.<br><br>3. Reading information and specification sheets on placement, finish and strength of lightweight concrete. | 1. Proposed increases in tonnage of concrete to be used in the future.<br><br>2. Potential for employment in the concrete industry.<br><br>3. Potential for advancement in the construction industry.<br><br>4. Potential solution of housing problem through use of precast modular housing components. |
| 1. Computation of pump volume and operating pressures. | | 1. The growth of leisure in U. S. and the effect on the construction industry.<br>a. Swimming pools<br>b. Concrete boats |
| | | |

## II. PRESENTATION OF INTEGRATED CONCEPTS

*RELATED CONCEPTS*

| *INSTRUCTIONAL TOPICS* | *TECHNICAL CONCEPTS* | *SCIENCE* |
|---|---|---|
| C. Sandwich walls. | 1. Precast concrete panels with 1-1/2" thick polystyrene between them.<br>a. Panels 2-1/4" thick<br>b. May be reinforced<br>c. Panels placed in position and columns cast<br>d. Curtain wall uses in a few cases | 1. Principles of pre-stressed concrete.<br>2. Heat and cold trans-mission.<br>a. BTU<br>b. Convection |
| D. Slip form concreting. | 1. Movable forms progress as concrete is mixed and placed.<br>2. Road building a major use.<br>3. Used for other large con-tinuous slabs. | |
| E. Concrete pumping and conveying. | 1. Pump design and pumping systems.<br>2. Pump placement.<br>3. Pumping mixtures.<br>4. Capabilities and limitations of concrete pumping.<br>a. Line size<br>b. Equipment capabilities<br>c. Site conditions<br>d. Additives for lubri-cating pump lines | 1. Various types of pumps and principles in-volved.<br>2. Compos[illegible]ion of addi-tive lubric[illegible]ts for concrete. |

*TO BE DEVELOPED*

| *MATH* | *COMMUNICATIONS* | *SOCIAL STUDIES* |
|---|---|---|
| 1. Developing an understanding of "R" factors and coefficients of heat loss. | | |
| | 1. Research and write an essay on an innovative advance or technological advance in concrete working or placing. | |

III. APPLICATION

A. Show film: No Longer a Luxury (Slip Form Takes Hold) to introduce lesson.

B. Discuss innovations in concrete working and relate technological advances to living styles.

C. Show film: Concrete in the Sixties--Report No. 9. Discuss pertinent aspects.

D. Take a field trip to observe shotcreting or highway paving machines in operation.

IV. EVALUATION CRITERIA GUIDELINE

A. Explain the principles involved in:
   1. Shotcreting
   2. Slip form paving
   3. Pneumatic pumping of concrete

B. List advances made in concrete working and uses of concrete.

V. SUMMARY

A. Concrete, as a construction material, is very versatile and man continues to devise machines and concrete mixes to increase its versatility. Developments such as shotcreting, slip form paving, pneumatic pumping, lightweight concrete, precasting, and prestressing vastly increase the use potential of concrete. Concrete working will increasingly become an important trade in the future.

VI. SUGGESTED TIME AND SEQUENCE LISTING

30 minutes -- Introduction and motivation

60 minutes -- Integrated curriculum concepts

60 minutes -- Show and discuss film: Concrete in the Sixties--Report No. 9

180 minutes -- Field trip

30 minutes -- Summary and evaluation

VII. SUPPLEMENTAL REFERENCES AND RESOURCE MATERIAL

1) Preplaced Aggregate Concrete for Structural and Mass Concrete, Detroit: American Concrete Institute, 1969.

2) Recommended Practice for Shotcreting, Detroit: American Concrete Institute, 1966.

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ACI 55-Year Index--1905-1959, Detroit: American Concrete Institute, Publications Department, 1960.

ACI Manual of Concrete Inspection, Detroit: American Concrete Institute, Publications Department, 1967.

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